

**GEFRA Münster**

**Quantitative assessment of  
the estimated impact of the  
NDP/NSRF using a  
macroeconomic model for  
the Czech Republic**

Project 05/5  
Ministry of Regional Development - Czech Republic

Final Report, 20 November 2006

by

John Bradley  
Vitezslav Pisa  
Gerhard Untiedt  
David Vavra

Münster, Germany, 2006



## CONTACTS FOR COMMUNICATION

### **GEFRA – Gesellschaft für Finanz- und Regionalanalysen**

#### **Dr. Gerhard Untiedt**

Ludgeristr. 56, D-48143 Münster, Germany,

Phone: +49-251-2 63 93 11

Fax: +49-251-2 63 93 19

Mail: [untiedt@gefra-muenster.de](mailto:untiedt@gefra-muenster.de)

Homepage: [www.gefra-muenster.de](http://www.gefra-muenster.de)

### **EMDS - Economic Modelling and Development Systems**

#### **Dr. John Bradley**

14 Bloomfield Avenue, Dublin 8, Ireland

Phone: +353-1-454 5138

Fax: +353-1-497 0001

Mail: [john.bradley@iol.ie](mailto:john.bradley@iol.ie)

Homepage: [www.esri.ie](http://www.esri.ie)

### **IREAS – Institut Pro Strukturální Politiku, O.P.S**

#### **Vitezslav Pisa**

Registered Address: Mařákova 292/9, 160 00 Prague 6

Office: Štěpánská 45, 110 00 Prague 1

Phone: +420 222 230 259 (secretary)

Fax: +420 222 230 261

Mail: [ireas@ireas.cz](mailto:ireas@ireas.cz)

Homepage: <http://www.ireas.cz>

#### **David Vavra**

Mail: [shef@centrum.cz](mailto:shef@centrum.cz)



## TABLE OF CONTENTS

Executive summary .....	i
1 Introduction.....	1
<b>PART I: THE NEW MODEL.....</b>	<b>4</b>
2 Review of macroeconomic modeling and related economic research on the Czech economy .....	6
3 The database for the HCZ5 model.....	18
4 The HERMIN modelling framework .....	23
5 Calibrating the HERMIN behavioural equations .....	37
6 Model testing and responses to shocks .....	58
7 Computer implementation of the HCZ5 model system .....	75
<b>PART II: THE NSRF EVALUATION .....</b>	<b>77</b>
8 NSRF ex-ante analysis with the new model.....	79
9 The NSRF impact results.....	90
10 Future developments in the Czech NSRF evaluation.....	113
References .....	114
Annexes .....	124



## TABLE OF CONTENTS

<b>List of tables .....</b>	<b>VII</b>
<b>List of figures.....</b>	<b>VIII</b>
<b>Executive summary .....</b>	<b>i</b>
<b>1 Introduction.....</b>	<b>1</b>
<b>Part I: The New Model.....</b>	<b>4</b>
<b>2 Review of macroeconomic modeling and related economic research on the Czech economy .....</b>	<b>6</b>
2.1 Introduction.....	6
2.2 Overview of general approaches and trends.....	6
2.3 Structural macroeconomic models designed to study policy issues and effects of stabilization policies .....	8
2.4 Structural macroeconomic models to study long-term growth, structural change and convergence prospects .....	15
<b>3 The database for the HCZ5 model.....</b>	<b>18</b>
3.1 Introduction.....	18
3.2 Stage 1: The “raw” data for the Czech HCZ5 model .....	19
3.3 Stage 2: The “generated” data for the Czech HCZ5 model .....	20
3.4 Concluding remarks on data issues.....	22
<b>4 The HERMIN modelling framework .....</b>	<b>23</b>
4.1 Introduction.....	23
4.2 Approaches to policy modelling.....	24
4.3 One-sector and two-sector small-open-economy models.....	25

4.4	The structure of the HERMIN model.....	26
4.5	The supply side of the HERMIN model.....	29
	(i) Output determination.....	29
	(ii) Factor demands .....	30
	(iii) Sectoral wage determination .....	32
	(iv) Demographics and labour supply.....	33
4.6	Absorption in HERMIN.....	33
	(i) Private consumption.....	33
4.7	National income in HERMIN.....	34
	(i) The public sector.....	34
	(ii) The national income identities .....	35
	(iii) The monetary sector.....	35
<b>5 Calibrating the HERMIN behavioural equations .....</b>		<b>37</b>
5.1	Introduction.....	37
5.2	The supply side of HERMIN – manufacturing .....	41
5.3	The supply side of HERMIN – building and construction.....	45
5.4	The supply side of HERMIN – market services.....	48
5.5	The agriculture sector .....	50
5.6	The non-market services sector .....	51
5.7	Demographics and supply of labour .....	52
5.8	The absorption side of HERMIN.....	52
5.9	Expenditure prices .....	53
5.10	Government expenditure.....	54
5.11	Taxation and revenue .....	55
5.12	The public sector borrowing requirement (GBOR) .....	56
5.13	National income.....	57
<b>6 Model testing and responses to shocks.....</b>		<b>58</b>
6.1	Introduction.....	58
6.2	Checking the model structure.....	58
6.3	A note on baseline scenarios .....	59
6.4	Projections: external and policy assumptions .....	61
6.5	A stylised projection for 2005-2020 .....	64
6.6	Shocking the model .....	70



---

(i) A shock to world output (OW).....	70
(ii) A public employment shock (LG).....	71
(iii) A shock to government investment (IGV).....	72
(iv) A shock to all exogenous price levels .....	73
(v) Conclusions on responses to shocks.....	74
<b>7 Computer implementation of the HCZ5 model system .....</b>	<b>75</b>
7.1 The software.....	75
7.2 Organisation of the computer files and folders.....	75
7.3 Simulating the model system .....	76
<b>Part II: The NSRF Evaluation .....</b>	<b>77</b>
<b>8 NSRF ex-ante analysis with the new model.....</b>	<b>79</b>
8.1 Introduction.....	79
8.2 Inserting the NSRF into the new model .....	79
8.3 The NSRF impact methodology for the new HCZ5 model.....	82
(i) Handling NSRF physical infrastructure impact analysis .....	82
(ii) Handling NSRF human resources impact analysis.....	84
(iii) Handling NSRF Research and Development (R&D) impact analysis .....	87
<b>9 The NSRF impact results.....</b>	<b>90</b>
9.1 Introductory Remarks.....	90
9.2 Other technical assumptions made in preparing the simulations .....	90
9.3 Overview of main NSRF impacts.....	91
9.4 Detailed descriptions of the NSRF impacts: notation .....	97
9.5 Detailed descriptions of the NSRF impacts: results.....	102
9.6 Conclusions on NSRF impacts.....	112
<b>10 Future developments in the Czech NSRF evaluation.....</b>	<b>113</b>

---

<b>References .....</b>	<b>114</b>
<b>Annexes .....</b>	<b>124</b>
<b>A Relevant empirical work for building macroeconomic models .....</b>	<b>126</b>
A.1 Production and factor demands .....	126
A.2 Consumer behavior .....	126
A.3 Wage behavior .....	127
<b>B Macroeconomic models on the Czech economy before 1998 .....</b>	<b>128</b>
<b>C The HCZ5 model TSP data batch files.....</b>	<b>130</b>
C.1: The five-sector (HCZ5) data files .....	130
C.1.1 CZBasicDAT.TSP: Basic data for HCZ5 HERMIN model.....	130
C.1.2 CZBandCDAT.TSP: Extracting the building & construction data .....	131
C.1.3 PRICEDAT.TSP: The NiGEM international price data .....	131
C.1.4 PRODUCTIONDAT.TSP: The NiGEM international production data .....	132
C.1.5 HERDATA_HCZ5.TSP: Generated data for HCZ5 HERMIN model .....	133
C.2: Assembling the new (HCZ5) HERMIN model database.....	166
C.2.1: HCZ5EXOG.TSP: The exogenous variables .....	166
C.2.2: HCZ5ENDO1.TSP: The endogenous variables (Part 1) .....	168
C.2.3: HCZ5ENDO2.TSP: The endogenous variables (Part 2) .....	168
<b>D A dictionary of the HCZ5 model variables .....</b>	<b>170</b>
D.1 The exogenous variables of HCZ5.....	170
D.2: The endogenous variables of HCZ5 .....	175
<b>E The HCZ5 model: calibration and WINSOLVE equations.....</b>	<b>183</b>
E.1: WINSOLVE model listing (annotated) .....	183
E.2: TSP calibration results.....	215
E.2.1 Joint factor demand systems for T, BC and MS sectors .....	215
E.2.2 Calibration results for sectoral output equations (OT, OBC and OMS) ..	234
E.2.3 Calibration results for remaining behavioural equations .....	249

---

<b>F Simulating the HCZ5 model: WINSOLVE batch files</b> .....	<b>286</b>
F.1: HCZ5HIST.LOG: Checking consistency with historical data .....	286
F.2: HCZ5PROD0.LOG: Projecting exogenous variables out-of-sample .....	287
F.3: HCZ5PROD1.LOG: Generating baseline projection from 2005 to 2020 .....	294
<b>GPolicy shocks: HCZ5 model WINSOLVE batch files</b> .....	<b>296</b>
G.1: HCZ5OW.LOG: Shock to components of world output.....	296
G.2: HCZ5LG.LOG: Shock to public employment.....	297
G.3: HCZ5IGV.LOG: Shock to public investment.....	297
G.4: HCZ5PRICE.LOG Shock to all exogenous prices .....	298
<b>HNSRF shocks: HCZ5 model WINSOLVE batch files</b> .....	<b>300</b>



---

**LIST OF TABLES**

Table 3.2.1:	Input of "raw" data series for HCZ5 database .....	19
Table 3.2.2:	HCZ5 XLS files for input to data generating process .....	20
Table 6.5.1:	Performance of macro aggregates in baseline .....	65
Table 6.5.2:	Sectoral output growth rates (percent) .....	66
Table 6.5.3:	Employment and unemployment levels (thousands) .....	67
Table 6.5.4:	Public and private sector imbalances .....	68
Table 6.5.5:	The inflation environment .....	69
Table 6.6.1:	Effects of 10% rise in level of "world" output (percentage change relative to baseline) .....	71
Table 6.6.2:	Effects of 10% increase in public sector employment (Change relative to baseline, thousands) .....	72
Table 6.6.3:	Effects of a 10% rise in the level of public investment (change relative to baseline, real Czech Koruna (1995)) .....	73
Table 6.6.4:	Effects of 10% increase in all exogenous price levels (percentage change relative to baseline) .....	74
Table 9.3.1:	NSRF impacts on the GDP growth rate .....	94
Table 9.3.2:	NSRF impacts on the level of GDP .....	95
Table 9.3.3:	NSRF impacts on the level of total employment .....	96
Table 9.3.4:	NSRF impacts on the level of economy-wide productivity .....	97
Table 9.5.1:	The without-NSRF baseline projection .....	102
Table 9.5.2:	The NSRF expenditures relative to ex-post GDP .....	103
Table 9.5.3:	The NSRF-induced increases in stocks of infrastructure, human capital and R&D .....	104
Table 9.5.4:	NSRF: impacts on macro aggregates .....	105
Table 9.5.5:	NSRF: impacts on manufacturing .....	106
Table 9.5.6:	NSRF: impacts on building and construction .....	107
Table 9.5.7:	NSRF: impacts on market services .....	108
Table 9.5.8:	NSRF: impacts on expenditure aggregates .....	109
Table 9.5.9:	NSRF: impacts on price levels and inflation .....	110
Table 9.5.10:	NSRF: impacts on public and private macro balances .....	111

**LIST OF FIGURES**

Figure 1:	Revised expenditure profile of the NSRF (euro million per year) .....	ii
Figure 2:	Revised pattern of expenditure (fraction of total per year 2007-2015).....	iii
Figure 4.4.1:	The HERMIN Model Schema.....	28
Figure 9.3.1:	Impacts of the NSRF on the growth rate of GDP.....	93
Figure 9.3.2:	Impacts of the NSRF on the level of GDP .....	93



## EXECUTIVE SUMMARY

The response of the Czech economy to the Structural Funds interventions for the period 2007-2015 will be divided into two different phases. First, the “implementations” years and second the phase where solely the supply side mechanism work.

During the seven “implementational” years (2007-2015) the response will be made up of two separate elements:

- i. A mainly demand-side element, which is driven by the expenditure of the NSRF funds on programmes of public and accompanying private investment.

and

- ii. A mainly supply-side impact that arise due to the gradual build-up of “stocks” of infrastructure, human capital and R&D, and the beneficial spillovers that will be generated both during and after the NSRF.

The complexity of analysing the impacts of the NSRF arises from the inter-mingling of these two separate processes, since in the real world, they cannot be distinguished. Only with a macro-sectoral model is it possible to identify and quantify the separate chains of demand and supply causation.

In particular, if one confined the NSRF impact analysis to the period 2007-2015 (i.e., the implementational period), the two separate effects would be very difficult to disentangle by simply observing the actual economic outturn. Other non-NSRF factors have influenced the performance of the economy of the Czech Republic in the past, and will continue to do so in the future (e.g., the Single market, foreign direct investment, the performance of the Czech Republic’s main trading partners, etc.). Furthermore, during the NSRF implementational period – 2007-2015 - the gradual build-up of large demand-side effects will dominate and the improved supply side responses will tend to be hidden.

In order to identify the separate supply-side impacts that will continue after the termination of the NSRF, we have to simulate the model out beyond the year 2015. In this report we terminate the simulations in the year 2020, i.e., five years after the termination of the NSRF. What the model-based analysis shows is that although the implementational impacts are large, they vanish almost completely after the year 2015. The supply-side impacts, although more modest, endure for many years, due to the spillover benefits of the improved stocks of physical infrastructure, human capital and R&D.

In this brief summary we present results of the impacts of the NSRF on aggregate GDP, aggregate employment and aggregate productivity – major macroeconomic aggregates. In the case of aggregate GDP impacts, one must make a very clear distinction between the impacts of the NSRF on the growth rate (which are transitory) and the impacts on the level of GDP (which are of a more long-lasting character. Starting with a specially prepared “without-NSRF” baseline projection, we then set the NSRF public expenditures at the levels described in the official Czech NSRF documents and re-simulate a “with-NSRF” outcome. The “with-NSRF” baseline is compared with the “without-NSRF” simulation, and the differences are taken as measures of the NSRF impacts. These differences are usually expressed as



percentage changes relative to the baseline, but can also be expressed as absolute differences from the baseline.

With respect to the NSRF impact on the growth rate of aggregate GDP, the most notable feature is that the NSRF is likely to cause a gradual rise in the growth rate after the year 2007, the year of first implementation. In 2007, the “with-NSRF” growth rate is 4.7%, while the baseline scenario “without-NSRF” growth rate is 4.3%, i.e., an increment of 0.4 percentage points due to the NSRF. After the year 2007, there are further significant increases to the growth rate, relative to the “without-NSRF” baseline. The other notable feature is the large negative shock to the growth rate (relative to the baseline “without-NSRF” growth rate) experienced in the year 2016 (by minus 2.2 percentage points), due to the assumed complete cessation of the NSRF funding after December 31<sup>st</sup>, 2015. After the year 2015, the “with-NSRF” and “without-NSRF” growth rates are almost identical.

This outcome is due to the fact that the revised proposals are that the NSRF will start with a modest initial expenditure of funds, and that the expenditure will be gradually “ramped up” thereafter, along the lines of Figure 1 below.

Figure 1:  
Revised expenditure profile of the NSRF (euro million per year)

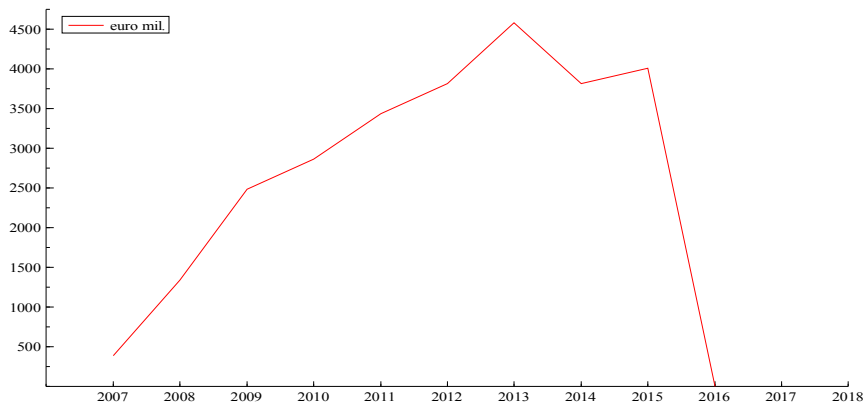
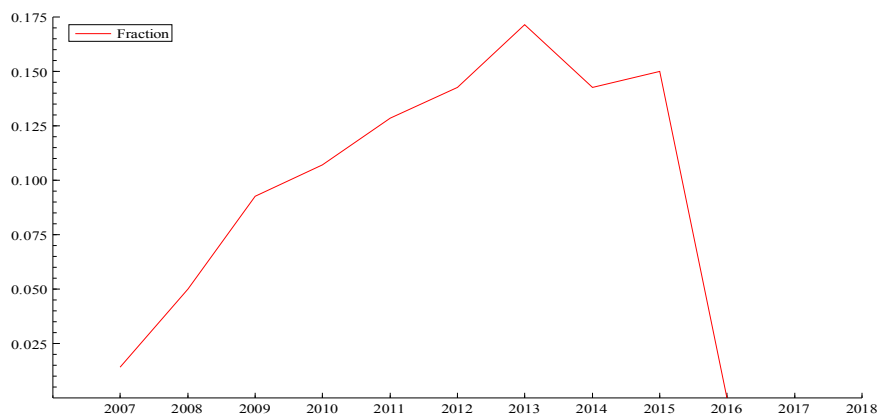


Figure 2:  
**Revised pattern of expenditure (fraction of total per year 2007-2015)**



In the previous analysis, the proposed expenditure pattern had been one where approximately one seventh of the funds was to be spent each year. Consequently, there was a big, positive shock to the growth rate in 2007 – at the start-up of the NSRF - and a corresponding negative shock in the year 2014 – when the NSRF is assumed to terminate. The revised proposals envisage a more orderly build-up of expenditure. However, they also propose a rather abrupt termination after 2015, from a very high level in the final year. In light of the present analysis, the authorities may consider revising this profile, to provide for a more gradual exit strategy. Alternatively, the final two years (2014-2015) may eventually overlap with a future NSRF programme for the post-2013 budgetary period.

We can also present the NSRF impacts on the level of GDP. Here, there is a gradual rise in the level of GDP in the initial year 2007 (a rise of 0.4 per cent, relative to the “without-NSRF” baseline level). Thereafter, there is a build-up in the level increase until the termination of the NSRF in the year , 2015, by which point the level of GDP is 4.6 per cent higher than the “without-NSRF” case. After the NSRF funding ends in 2013, there is a downward adjustment in the level of GDP, and by the year 2020 the level of GDP is still 1.6 per cent higher than the “without-NSRF” case.

The NSRF impacts on the labour market is usually presented in terms of the net increase in numbers employed. The initial effect in 2007 is to increase total employment by just over 20 thousand jobs. This builds up to 196 thousand jobs by the year 2013, and is still 178 thousand in 2015. In 2016, there is a sharp downward adjustment in the employment gain (from 178 thousand to 56 thousand), as the NSRF funding ceases and there are direct and indirect job lay-offs. By the year 2020, i.e., seven years after the termination of the NSRF, the level of total employment remains higher than in the without-NSRF baseline by 29 thousand.

One of the most important effects of the NSRF will be its impact on the level of labour productivity (i.e., aggregate GDP per worker). This is a crucial measure of how well the NSRF investment programmes might boost welfare through raising the productivity and competitiveness of the economy. The overall picture is one of a gradually increasing level of productivity, measured relative to the “without-NSRF” baseline. It should be stressed that the level

of productivity will already be rising in the “no-NSRF” baseline. The NSRF increases the level of productivity even further.

These impacts assume that the size of the so-called „spillover“ effects of improved infrastructure, human capital and R&D are in the mid-range of the effects reported in the international literature. In the absence of a detailed ex-ante microeconomic evaluation of the NSRF, this is a reasonable assumption to make. If such a microeconomic evaluation suggested that the individual measures in the NSRF were fine-tuned to optimise the impacts on the economy, then higher values of the macro spillover parameters would be justified, and higher macro impacts would be likely.

---

## INTRODUCTION

The process and mechanisms of cohesion or catch-up can be studied in many different ways. But since convergence is a systemic process that involves all aspects of the economy, for its study there is a need for a systematic economy-wide analytic framework. These systemic processes need to be analysed not just in isolation, but also within frameworks that capture the feedbacks and interrelationships within the overall macro economy. These usually take the form of macroeconomic models and draw on economic and econometric research findings. The HERMIN-type macromodels of the EU periphery have been used during the 1990s to explore these cohesion processes, including the structural changes induced by trade liberalisation, increased flows of foreign direct investment, rapid technological change and EU-financed CSF programmes of infrastructural and human-capital development (Bradley *et al.*, 1995a; ESRI, 1997).

The inspiration for the initial work on the model of the Czech Republic came from the earlier EU cohesion country models, since the structural changes taking place in the Czech Republic had clear similarities to those that occurred previously in EU cohesion countries and regions like Ireland, Greece, Portugal and Spain (Bradley and Zaleski, 2003). By the late-1990s, the processes of change in countries like the Czech Republic had become somewhat more predictable as new institutions and policies based on market economics gradually replaced the central-planning of the earlier era and as generally steadier growth resumed from a lower base level of activity after initial severe downward adjustments. Hence, a *quantitative* exploration of the impacts of policy decisions, against the background of a progressively stabilising economic system, became both desirable and feasible.

HERMIN models had already been used within the EU, for example in a study of the likely macroeconomic impact of the Single European Market (SEM) and the Structural Funds (or Community Support Framework (CSF)) on the EU peripheral economies (ESRI, 1997). A key finding of that study was that as trade liberalisation proceeds, major sub-components of the manufacturing sector as well as some aspects of services switch from being essentially non-tradeable to being internationally tradeable. In the case of the SEM and the CSF programmes, this change results from the dismantling of non-tariff barriers such as restrictive public procurement policies or from, for example, a decline in transport costs arising from improved access infrastructure. Similar considerations apply during the transition of the CEE countries as part of their move towards EU membership.

In this paper we describe the revision, extension and major updating of the Czech Republic HERMIN model, a first version of which was described in Kejak and Vavra, 1997 and which was also used in Barry, *et al.*, 2003. The report is structured into two Parts as follows. Part I consists of Sections 2-7, where the new Czech HERMIN model is described in detail. In Section 3 we provide a brief overview description of the database of time series that was constructed to support the HCZ5 five-sector development of the original Czech HERMIN model. Full listings of the TSP batch files are provided as an Annex. In Section 4, some

background to the theoretical underpinnings and assumptions used by the HERMIN modelling framework are presented. In section 5 we describe how we calibrated the model's behavioural equations using Czech Republic national accounting and other data from the period 1995-2004. The first version of the model had used data up to the year 1997, but in the intervening years the Czech Republic National Accounts have been completely reformulated and the revisions have been carried back to the year 1995. Our present sample extends to the year 2004, giving us 10 annual observations. We pay particular attention to changes in the model parametrization due to the new and extended database.

In section 6 we describe how the model was implemented, tested, and used to prepare a preliminary stylised baseline projection for the Czech Republic economy out to the year 2020, using the WINSOLVE modelling software developed by Pierse, 1998. This baseline projection is then used to subject the model to a series of policy and other shocks designed to explore its behavioural responses.

In section 7 we describe how the economic mechanisms in the Czech NSRF have been incorporated into the HCZ5 model, in preparation for the subsequent use of the model to carry out ex-ante impact evaluations. Section 10 concludes and outlines the future Czech Republic HERMIN modelling agenda, which will include use of the new model to carry out extensive ex-ante impact evaluations of the Czech Republic National Strategic Reference Framework and its associated public sector investments in infrastructure, human resources and direct aid to private sector productive activities..

Part II of the report deals with the application of the new Czech HERMIN model to the ex-ante analysis of proposals for the Czech NSRF 2007-2013. It is organised as follows.

Section 8 presents a detailed account of the NSRF impact evaluation methodology, extending on the description given previously in the first Report (Bradley, Pisa, Untiedt and Vavra, 2006: henceforth, Report 1) . In particular, it describes the important role played by the improvements in physical infrastructure, human resources, and research and development (R&D) that will be implemented through the NSRF investment programmes. The new element here, compared to Report 1, is that we have now included mechanisms that can analyse the impacts of R&D, and its spillovers into increased output and factor productivity.

Section 9 presents the NSRF impact results. After introductory remarks and a note on technical assumptions, we then present an overview of the main impacts, followed by a more detailed examination of the sectoral and other consequences. It should be noted that in the first version of Report 2, we made use of preliminary NSRF data on the proposed financial allocations. In this revised draft, we have made use of the latest versions of the financial allocations. In the first version we had assumed that the data presented to us was in constant prices, and we indexed the data to take account of inflationary developments between 2004 and 2013. However, in the latest financial allocations it has become clear that the earlier data were in current prices, and already included a form of price indexation. Consequently, the present results show somewhat smaller impacts compared to the first draft of Report 2, mainly due to the erroneous over-indexation of earlier data.

Section 10 concludes with a short note on some issues that are under continual review and in need of further research effort.

After the bibliography, the report concludes with a series of technical appendices that provide a complete dictionary of all the variable names used in the model and a full listing of the WINSOLVE batch files that were used to simulate the model. These will only be of interest to

readers who need to be familiar with the technical computation aspects of the HERMIN-based NSRF evaluation methodology.

## **PART I: THE NEW MODEL**

---

## REVIEW OF MACROECONOMIC MODELING AND RELATED ECONOMIC RESEARCH ON THE CZECH ECONOMY

### 2.1 INTRODUCTION

The modeling research of the Czech economy has been relatively scarce in the past decade or so, despite many important policy questions arising in the context of economic transition and EU integration. The challenges posed by modeling of the rapidly changing transition environment has often proven hard to overcome, especially in the realm of structural economic models designed to answer particular policy questions or study long-term growth issues. As a consequence, there have been only a few structural macroeconomic models developed that would be regularly used for analysis and communication of short and long-term policy issues. In policy making institutions, such as the Ministry of Finance (MoF) or the Czech National Bank (CNB) a structural approach to economic modeling only recently replaced reduced form forecasting relationships, and much of this research is not in the public domain. However scarce, the existing models are often innovative and comprehensive pieces of work, as the model builders could not draw much on other existing approaches and empirical evidence for modeling particular economic sectors has also been very limited. The scarcity of the empirical evidence is in part due to the lack of reliable and long data series.

This review summarizes publicly available research work on structural macroeconomic models of the Czech economy,<sup>1</sup> with a special emphasis on the work done since late 1990s. After characterizing the general approaches in the next section, the review continues with more details on modeling of two economic areas where structural macroeconomic models have most often been used: i) monetary and fiscal policy issues and effects of stabilization policies, ii) long-term growth, structural change and convergence prospects. The appendix contains a review of empirical evidence on modeling individual economic sectors as well as a brief summary of the macroeconomic modeling of the Czech economy in the period before 1998.

### 2.2 OVERVIEW OF GENERAL APPROACHES AND TRENDS

The economic analysis of policy issues facing the Czech economy in connection with the processes of transition and entry into the EU necessitates formal economic modeling. The questions asked are typically those that cannot be answered without a structural economic model. Trade liberalization, inflow of foreign direct investment, and rapid technological

---

<sup>1</sup> While drawing on available publications as much as possible, at times the review also uses information coming from seminars and unpublished research work in as much as it has been generally known in the research community.



change experienced in the 1990s have brought structural changes in the economy, whose understanding, let alone policy implications, require a comprehensive context of a macroeconomic model. The same holds with respect to a whole new set of economic policy issues arising in the context of the EU integration. Entry into the Single Market, EU fiscal redistribution through CSF or harmonization of the legal and environmental standards with the EU are likely to seriously impact on the economic activity of various production sectors of the economy as well as welfare of different types of households.

Structural macroeconomic models of the Czech economy have been beneficial in designing macroeconomic stabilization policies as well as in discriminating among approaches to sustainable long-term policy framework. Macroeconomic modeling brings value either by helping to i) forecast more accurately macroeconomic developments given a particular set of assumptions, or ii) to understand the features and implications of underlying economic processes. The latter goal is usually achieved by developing and analyzing model based scenarios of macroeconomic developments under various contingencies ('what if' questions) regarding policy variables or other assumptions. The structural macroeconomic models have been found most useful in analyzing policy scenarios and putting consistency on forecasts in the medium-term; their role in forecasting accurately in shorter term has been limited. In forecasting accurately, a combination of a wide range of techniques has usually been preferred. The forecasting techniques range from spreadsheet based systems with a various degree of sophistication, simple reduced form equations to structural approaches modeling interactions between several economic sectors or the whole economy.

The building of structural economic models of the Czech economy have often been promoted by governmental institutions that gradually came to recognize their power in answering policy questions. For instance, both the CNB and MoF have been building their internal structural models since 2000 with a view to use them for policy analysis or/and forecasting. As a tool for policy analysis, these models have allowed to simulate the responses of several variables, such as inflation or output to particular shocks (e.g. VAT changes) under alternative scenarios of economic developments. They allowed isolating the effects of individual shocks, and comparing those effects under different policy frameworks. In this context, structural models have particularly been useful for answering "what-if" type questions and analysis of risks involved in particular scenarios. As a tool for forecasting, they allowed coherent story telling (i.e. they eased understanding of the economic phenomena behind the evolution of variables in the projection), which was a crucial element of designing monetary and fiscal stabilization policies sustainable in a medium-term.

Outside the government sponsored research, modeling has been relatively scarce, and mostly directed at issues of long-term growth and convergence. Some researchers would follow and complement the modeling in the policy institutions, constructing models to both address the issues of short-term stabilization policies as well as seek policies sustainable from the long-term. As an example of the strong role government institutions have played in initiating modeling research of the Czech economy, computable general equilibrium (CGE) models had been practically non-existent until few years ago, when various ministries (Trade and Industry, Finance, and Environment) became sponsoring research in the area.<sup>2</sup> This is especially intriguing as such models have been widely employed in other small economies

---

<sup>2</sup> Bruha (2002) gives a useful overview of the early literature in this areas, and mostly discusses theoretical concepts. Rättinger and Tousek (2004) apply a static CGE neoclassical framework in assessing economy wide impacts of adopting a CAP after the EU accession. Several scenarios of CAP adoption are employed. Much of the other CGE work is not in a public domain.

(often outside the government institutions) to study effects of tax changes and other measures on resource allocation between individual production sectors or households types, often in environmental context. Hence, although lacking a dynamic perspective, the CGE approach would have seemed to be a good tool for addressing many of the economic policy issues that policy makers in the transition countries have to tackle in the last phases of integration to the EU.

An important exception to the rule that macroeconomic modeling has been initiated by policymaking institutions was the construction of medium scale macro-model HERMIN CR under the ACE Phare auspices (Kejak and Vavra, 1999a).<sup>3</sup> Building on an international tradition and experience (see e.g. Barry *et al.*, 1999, Simoncic *et al.*, 1999, or Ciupagea *et al.*, 1999), it was one of the first successful attempts to provide a suitable tool for economic policy experiments (especially on the fiscal side). The model has been repeatedly used for both scenario development (Kejak and Vavra, 1999b) and analyses of economic impacts of structural funds disbursement. It has also been employed in policy analyses for the Ministry of Finance and the Czech National Bank, especially as regards works on the EU Pre-Accession Economic Programs.

The general scarcity of macroeconomic models of the Czech economy in part indicates how resource intensive model building and maintenance is (hence the role of government institutions), but also reports on data constraints faced by researchers in empirical work in transition economies. The lack of reliable and consistent time series, especially regarding real data (OECD Country Report, 1997, ECB Structural Model Report, Annex II, 2004) has indeed been a serious obstacle to modeling of the Czech economy. Calibration techniques are widely employed by researchers to overcome the data shortage. Two trends are visible: the econometric techniques used are relatively simple (OLS, ECM), while at the same time there is rising reliance on additional evidence provided either by sophisticated techniques (e.g. GMM or Bayesian inference in the case of monetary policy models) or other research and economic theory.

### **2.3 STRUCTURAL MACROECONOMIC MODELS DESIGNED TO STUDY POLICY ISSUES AND EFFECTS OF STABILIZATION POLICIES**

This area is relatively most developed, as the progress in research was spurred by the demands of running countercyclical monetary and fiscal policies, while ensuring fulfillment of the EMU nominal convergence criteria.

#### ***Monetary Policy***

In the fixed exchange rate arrangement before the IT regime, macroeconomic models had much less direct policy impact. For instance, Stavrev (2000) estimates a small continuous time macro-econometric model of the Czech economy. The model is built as a system of

---

<sup>3</sup> ACE-Phare project P96-6242-R ("Macroeconomics and Structural Change in Transition Economies: Common Themes in CEE and EU-Periphery Countries") For a more complete description of the background to the prototype HERMIN model, see Bradley *et al.*, 1995 and ESRI, 1997.

twelve non-linear differential equations and used to determine the nominal equilibrium exchange rate of the Czech koruna. The paper also investigates the effectiveness of monetary and fiscal policies in the presence of a fixed exchange rate regime and massive capital inflows. In a related work, Stavrev (2000b) compares structural characteristics between the Czech and Hungarian economies using the same structural specifications. While insightful, these models could only be used to study a particular question (effectiveness of monetary policy), but not to support daily operation of the monetary policy regime. The appendix contains more details on the research in the monetary area prior the introduction of IT.

Modeling research for analysis of IT issues have primarily focused on two tasks: i) identifying and describing the channels of the monetary policy transmission, and ii) setting them against a realistic background of longer-term economic trends the monetary policy has no ambition to influence directly through its instruments. The latter task involved distinguishing between long-term economic trends and short-term cyclical fluctuations in the observed data, for which structural models have been very useful too (see later). The outcomes of the research would be used in supporting the monetary policy on a daily basis, as the model based analysis and projections would stand at the center of the CNB's staff macroeconomic projections and policy recommendations.

Invariably, the researchers have preferred small and parsimonious models in analyzing the monetary policy issues and shock transmissions. Initially, they also preferred small models for forecasting too. A vast majority of the small models constructed shares a New-Keynesian paradigm (Clarida, Gali, Gertler, 2000). Examples include a small model of Vasicek and David (2004), Hsing's (2004) version of Romer's IS-MP-IA model, or the core forecasting model of the Czech National Bank (Benes et al. 2003a). Only more recently the attitude has changed, as the Czech National Bank began developing its dynamic general equilibrium models.

The Czech National Bank has been the natural institution promoting the research in the area, but some of the relevant research work was also produced outside its auspices. In any case, a vast majority of the research has been put into public domain in accordance with the transparency principle of operating Inflation Targeting regimes.

The Czech National Bank have been developing a suite of models organized around a core medium-term projection model since 2000, following an established international tradition. While a variety of structural models is needed to support the forecasting and policy analysis required for running the IT regime, the central banks typically entrust the core of the transmission mechanism into one single model (core model) and have other models (modeling suite) focus on specific issues not captured by the core model. The modeling suite of the CNB (Polak and Vavra, 2003) consists of a relatively simple core projection model, complemented by a larger structural econometric model of Hermin type, models tailored to the analysis of the external and fiscal sector, as well as a number of modeling techniques involved in forecasting short-term economic developments and recovering medium-term trends from data. More recently the CNB had been constructing a larger dynamic general equilibrium core projection model to replace the original simple core model and streamline its somewhat cumbersome interactions with some of the supporting tools from the modeling suite.

The core projection model of the CNB is a relatively simple model of monetary transmission in a New-Keynesian tradition, employed by many other central banks. These simple models, embodying just the basic principles and elements of monetary policy transmission within a

highly stylized structure of the economy are sometimes called as ‘first generation’ models supporting IT monetary policy. These models are invariably descriptions of a forward-looking transmission mechanism, featuring flexible exchange rate and interest rate reaction function of monetary policy. Other such models have been constructed to study monetary policy issues in the Czech economy outside the CNB, including e.g. Vasicek and David (2004) or Hsing (2004).

Like its peers, the CNB’s core projection model is built on the principle of monetary (super) neutrality ensuring no relationship between nominal and real variables in the long-term. Its steady state is therefore properly defined to ensure fulfillment of the inflation target, while real variables are on their long-term trends that come largely exogenous to the model. In the shorter-term, the transmission of monetary policy exploits the temporary relationship between nominal and real variables working through three channels: i) a fast channel, in which nominal exchange rate reaction to interest rate changes is passed to inflation through import prices, ii) a slow channel working through real exchange rate, in which the nominal exchange rate reaction also makes real exchange rate move off its trend (‘equilibrium’) affecting output (‘output gap’) and inflation, iii) a slow channel working through real interest rates, in which nominal interest rate changes move real rates away from their long-term trend (‘equilibrium’), affecting output (‘output gap’) and inflation. This transmission is forward-looking and rationally formed agents’ expectations are an important inflation forming factor.

The core model has essentially four behavioral mechanisms<sup>4</sup>: i) an IS curve relating deviations of output from trend (output gap) to the deviations of real interest rate and exchange rates from their trends, ii) a Phillips-curve, relating inflation movements to output gap movements, imported inflation and inflation expectations, iii) a UIP condition, modeling exchange rate movement on the basis of expectations about future movements of the interest rate differential between domestic and foreign interest rates, iv) an interest rate reaction function, relating interest rate movements to expected deviations of inflation from the target and output from its long-term trend (output gap).

The data and empirical work supporting the monetary policy models have been focused on i) calibrating the structural models parameters, ii) uncovering trends and cyclical fluctuations of macroeconomic variables. As for model parameters, the lack of long data series, their limited reliability and coverage have lead (as in other EM countries<sup>5</sup>) to i) a shift away from the traditional econometric techniques, and ii) to data work done on an analytical, rather statistical basis (Benes et al, 2005). As a result, the econometric techniques used to analyze data and retrieve the coefficients have been in part relatively simple (OLS, ECM), while at the same time there has been a rising reliance on additional evidence provided either from sophisticated techniques (e.g. GMM, Maximum Likelihood in Kalman filters, Bayesian inference, see e.g. Hurnik, Navratil, 2004, and Hrebicek, 2006) or other research.

As an example of this empirical approach, the CNB’s core projection model equations are largely calibrated.<sup>6</sup> The necessary theoretical restrictions on model parameters would often

<sup>4</sup> There are eleven behavioral equations, but most of them are derived from the four basic ones, there are other about 40 identities and memo items in the model.

<sup>5</sup> See e.g. the ECB’s Structural Model Report, Annex II, 2004.

<sup>6</sup> As an example of model parameters: output elasticity of inflation in quarterly annualized rates is about 0.5; real interest and real exchange rate elasticities of output about 0.25 and 0.15 respectively. The nominal exchange rate pass-through of import prices into inflation is about 0.25 on impact.

not be supported by limited data series in the economy undergoing substantial structural changes, and purely data driven parameters would have problematic relevance for the future. More importantly, in order for the model to serve monetary policy well, it has to have realistic model properties in terms of responses of model variables to temporary and permanent shocks, which became the defining principle of the model calibration.<sup>7</sup> Nevertheless, the model parameters have undergone a regular data based scrutiny and most recently the model has been 're-estimated' using Bayesian techniques (Hrebicek, 2006).

Much of the empirical research has been devoted to uncovering and modeling the long-term trends of real variables and retrieving statistical properties of the economic cycles to be addressed by structural models. Especially for the small models (such as the CNB's core projection model in Benes et al., 2003a) to function properly as forecasting and policy analysis models, the concepts of 'equilibria' (or better, long-term trends) of real variables and deviations from these trends (e.g. output gap) need to be properly defined and identified on the history and also projected into the future. Some authors have used simple data driven filters and/or production function estimation (for instance, Hajek and Bezdek, 2001, or Navratil and Hurnik, 2005). While useful in its own right, these estimates are not directly relevant for the small monetary models. For instance, the concepts of potential output and output gap in the small models have very restricted meanings as the inflation non-accelerating inflation level (NAIP, see e.g. Vasicek et al., 2002) and inflation relevant part of output respectively.

Uncovering the trends of output, real interest and exchange rate on history has been a subject of intensive research, usually employing Kalman filtering techniques based on structural model specifications (see e.g. Benes et al., 2003b). Some of these works have also used the maximum likelihood techniques involved in Kalman filtering to uncover the structural parameters of their model equations. They also employed variants of the CNB's core model to explore other relationships, e.g. using the concept of NAIRU instead of potential output (see e.g., Vasicek et al., 2002 for using iterated Kalman filter specification in estimating an augmented PC relationship, or Hrebicek and Vlcek, 2006, in estimating NAIRU using similar techniques in a structural model with a non-linear Phillips-curve).<sup>8</sup>

In addition to describing the long-term trends in the data, the researchers studied the statistical properties of the fluctuations around these trends too. These properties have been used as descriptions of the relevant 'stylized facts' the models should aim to capture. They were also employed in formal model evaluation through examining the model's capacity to match certain first and second moments of data. As explained above, many have used structural models in Kalman filters for that purpose. Others have used a different approach. Hsing (2004), for instance, uses Garch method on Romer's IS-MP-IA framework to find reduced form correlations between output, and nominal variables such as inflation and exchange rate depreciation. On the other hand, Benes and Vavra (2005) take a purely data driven ap-

---

<sup>7</sup> The model properties feature a sacrifice ratio of about -0.7% in response to a permanent unitary disinflation shock. With respect to temporary shocks, the exchange rate pass-through to inflation (y-o-y) is about 0.3 within the next 4 quarters, and a shock to output raises inflation by about 0.3 in about 4 quarters. In terms of a policy shock transmission (1% shock to interest rate), effects of output culminate at about -0.3 % in 3 quarters, with some overshooting after 6 quarters. Exchange rate reacts on impact by 1.2% and fluctuates thereafter, while inflation (year on year) culminates in 5 quarters at -0.2.

<sup>8</sup> The elasticity of a quarterly annualized rate of inflation to unemployment rate deviations from NAIRU (relative to a deviation from a lower bound of unemployment rate) is 0.25.

proach, without information coming from a structural model, and describe economic cycles through eigenvalue decomposition of the underlying time-series.

The small models have proven to be good research tools to study many of the monetary policy issues; but they also have a number of disadvantages, especially in daily support of monetary policy making. For instance, the CNB's core projection model, though based on a New-Keynesian paradigm, is relatively ad-hoc in that it is not derived from first principles, making interpretation of certain economic phenomena difficult. Being relatively simple, its capacity to answer questions outside the transmission mechanism (for instance, concerning current account and public sector deficits) is very limited and has to rely on other models. Its loose treatment of long-term trends means that important questions about the monetary policy have to be imposed from outside the model as assumptions. As highly calibrated, its forecasting accuracy and ability to track history is limited too. Nevertheless, the model has been found very useful for guiding monetary policy and also for its ability to incorporate various views, organize thinking and research in the institution, and also for its capacity to analyze risks by asking 'what if' questions.

Realizing the limitations of the small models in addressing wider economic questions with enough economic consistency, the researchers began experimenting with Stochastic Dynamic General Equilibrium (SDGE) models. As a tool for policy analysis, SDGE models allow much broader possibilities to simulate consistent responses of the economy to shocks under alternative scenarios than the smaller ad hoc models. They allow for isolating the effects of shocks, and comparing those effects under different policy frameworks more easily too and for many more economic variables. As a tool for forecasting, the virtues of SDGE models are not yet much explored, but they should allow for even more coherent story telling than other structural models.

Laxton and Pesenti (2003) were first to analyze the Czech monetary policy issues in a dynamic general equilibrium setting by building a calibrated two country DSGE model, in which the Czech economy was modeled as a small open economy interacting with the Euro Area as a large economy. The properties of the Czech model economy were calibrated according to the properties of the CNB's small core projection model (Benes et al., 2003a). This research work was a part of the project developing the IMF's Global Economic Model (GEM). GEM is a particularly malleable general equilibrium framework that can be applied and calibrated in many different country settings.

The Czech National Bank has began building its own DSGE model too (Benes et al., 2005). The view is to use the model for ad hoc policy analysis in the initial stage and to replace the current core projection model later. The CNB researchers have decided to develop an own model from scratch, rather than adopting the GEM framework, largely because the latter appears very complicated to be used for daily forecasting and analytical work.

The CNB SDGE model (Benes et. al, 2005) has been built around a relatively parsimonious economic structure. It is a representative agent economy with Ricardian features, making it less useful for analysis of fiscal sector issues. Consumers consume differentiated final goods and supply raw labor with infinite elasticity of labor supply in a competitive market. The consumer inter-temporal smoothing is affected by accumulation of habit from past consumption. Labor agencies differentiate the raw labor, mark-up the wages and supply the differentiated labor types in a monopolistic market to final goods producers preferring a variety of labor types in production. The production takes place in stages too. Final goods producers use a Cobb-Douglas technology in producing a domestic value added out of labor and capital (with time to build and investment adjustment costs) that is combined in a CES bundle with im-

ported intermediate goods in a gross production function (elasticity of substitution below unity). Retailers buy the final goods from producers in a competitive market, differentiate it, marking-up the price and sell the varieties to consumers home and abroad. The agents in monopolistic markets are constrained in optimizing their prices in a Calvo style, leading to stickiness in nominal prices and wages. With the latter being larger than the former, the model exhibits a real wage stickiness too.

### **Fiscal Policy**

Intensive research has been undertaken in recent years in analyzing effects of fiscal policies on macroeconomic stabilization, sustainable levels of government debt, and evolution of pension system under alternative regulative frameworks. Most of this research, however, had been done under the auspices of various ministries and institutions (especially the Ministry of Finance, MoF), and to the best of our knowledge is not in the public domain, making the assessment of the existing models difficult.

The Ministry of Finance has been working on a (suite) of model(s) to help with their macroeconomic projections. In addition to helping with quarterly macroeconomic forecasts, the models were meant for budget planning, construction of Pre-Accession Economic Programs (PEP),<sup>9</sup> and a number of ad hoc macroeconomic and policy analyses. Initially, forecasting accuracy was important and the approaches to model identification emphasized a strong link to the properties of available data (usually at high frequency). Later, the emphasis has shifted from an accurate forecasting model to a suitable tool for simulating alternative scenarios of economic development.

Currently, a small econometric model is being developed under the cooperation with the SEOR (Erasmus University Rotterdam) since 2004/05, with the view of constructing a model similar to models employed by similar institutions in other European countries (such as Manège, French Ministry of Finance, QEM-ECM, Infostat or Macmod, Macedonian central bank). Similarly to these models, the estimated single good model would have a clearly specified demand and supply block, explicit wage formation and the labor market, full national account consistency on the incomes side and cover endogenously most of government revenues. The demand side would have explicit modeling of all expenditure components, including separate equations for exports and import demands. The wage formation process takes into account productivity, prices, output gap<sup>10</sup> and a tax wedge in a standard way. All other elements of household disposable income (such as social security payments and taxes) are modeled endogenously. The model allows for a fiscal closure rule that tracks a given path of the government debt, making wages in the government sector as a residuum. The supply side is modeled in stages, where the optimal level of output is brought down through cost minimization into optimal demands for labor and capital, while the actual levels of factors gradually adjust to these levels.

In addition to the dynamic macro econometric models the Ministries of Finance and Industry&Trade (MIT) engage with SEOR in building a CGE modeling suite. Although originally

---

<sup>9</sup> In early 2000s, an independent model based analysis of the PEP macroeconomic projections was performed by the IEEP, an independent research institute. A variant of Hermin CR model was used in the evaluations.

<sup>10</sup> The output gap is defined as the actual output over the potential.

designed to support economic policy formulation in the MIT through comparative static analysis of various shocks,<sup>11</sup> its dynamic version has also recently been used for simulations of the government debt developments under various scenarios and policy rules.

A number of versions of a CGE model been constructed under the project. The core CGE model (Vonka, van der Windt, 2005) has 11 main sectors (out of which 3 are manufacturing), four types of agents (household, government, enterprise, and rest of the world). The production functions are nested CES bundles between the domestic value added and intermediates, and between labor and capital. Further specifications are made on the level of prices (tariffs, taxes, mark-ups), imports (competitive or complements) and exchange rate (based on foreign trade decomposition). The price setting is a mix of a small open economy assumptions and mark-up pricing in sheltered sectors. The static version of the model is closed through investment-savings balance that makes sure that the exchange rate is held constant or that exchange rate moves to keep the flow of foreign savings constant. The model is based on NA 2000 and is calibrated according to realistic impulse responses with the help of SAM matrices, but also using econometric estimates. The core model is supported by more detailed static models working with a two-digit NACE aggregation.

To render the CGE model to dynamic simulations, the static model is repeatedly simulated with the feedback to a block of exogenous variables, described using a dynamic econometric specification. Dybczak and de Haan, 2005 use this model in order to derive trajectories of public debt and macroeconomic adjustments on the basis of budget targeting supported by adjustments in i) public investments, ii) public consumption, or iii) taxes. Several budget adjustment schemes are analyzed, including a fixed deficit/GDP rule.

Under the same project both MoF and MIT also cooperate in building specific models to address particular sectors or questions. These models are often clones of the core CGE model. One such model has recently been used to study impacts of export stimulus to the economy.<sup>12</sup> The model is a dynamic semi-general equilibrium model with sector breakdown, featuring neoclassical supply side with production function in individual sectors defined as CES or Leontief aggregates on the basis of input-output tables.

Only a few analysis of public finance developments have been published:

- In an interesting paper, Hurnik (2004) uses a dynamic (non-stochastic) general equilibrium model in examining the implications of alternative fiscal consolidation programs for small open economy. In the calibrated framework, he quantifies the impact of the deficit

<sup>11</sup> Given the emphasis of the MIT on stimulating environment for private sector economic activities and promoting international trade of the Czech Republic, the project's original focus was on modeling individual industries, their competitive position and the ability to capture structural change.

<sup>12</sup> While the model is not in a public domain and is work in progress, the model properties had been discussed on seminars. In particular, the export GDP multiplier is about 1.45 %. The multiplicative effect of an export impulse is contained by the high import intensity of the sectors most affected by the positive export stimulus (such as chemistry and machinery). The model's calibration implies the overall import intensity of export of 0.5. (i.e. for 1 CZK of exports 0.5 CZK of imports is needed), including both the imports of intermediates as well as the second round effects of higher income. The shock leads primarily to the expansion of industry (by 65% of the overall economic expansion), while services relatively contract (35% of the overall expansion). The employment effects are more balanced, as the higher labor intensity in services compared to industry helps the service sectors enjoy 50% of the overall employment rise (0.3%).



financing and fiscal consolidation on consumption and saving of households, investment of firms and thereby on the capital stock and real interest rates. He also investigates cyclical and long-term implications of deficit financing and fiscal consolidation for monetary policy using the interest rate link. Finally, he performs and compares several fiscal consolidation scenarios in the context of the model.

- In a widely acclaimed policy research work, Bezdek et al. (2005) use macroeconomic scenarios to explore macroeconomic implications and sustainability of pension system reform variants proposed by individual political parties.
- Bezdek and Stiller (2000) analyze the relationship between taxes (value added, excise, corporate income, personal income, and social-security contributions) and selected macroeconomic variables (especially, GDP and wage growth) using several linear regression specifications. Though their approach could be used for projecting short-term fiscal outlooks (taking the structure of the budget as given), its usefulness for analyzing policy scenarios was limited.
- Ciżkowicz and Rzońca (2005) examine non-keynesian effects of fiscal contraction policies in new EU member states.

## **2.4 STRUCTURAL MACROECONOMIC MODELS TO STUDY LONG-TERM GROWTH, STRUCTURAL CHANGE AND CONVERGENCE PROSPECTS**

A number of model based approaches have been used to study long-term growth, structural change and convergence prospects of the Czech economy, especially in connection with the EU accession and transition processes. The researchers employed a spectrum of models ranging from medium scale econometric models to endogenous growth models.

Hermin CR macromodel has proven to be very malleable in many contexts. The generic HERMIN model is a macro econometric model composed of four sectors: Manufacturing (traded sector), Market Services (non-traded sector), Agriculture and Government with the two latter being largely exogenous or driven by a simple time trend. Conventional Keynesian mechanisms are at the core of the HERMIN model. Thus, the absorption and income distribution subcomponents generate the standard income-expenditure mechanisms of the model. However, the model also has neoclassical features, mainly associated with the supply subcomponent. So, output in manufacturing is driven by both demand and cost competitiveness, where firms seek out minimum cost locations for production. Factor demands in manufacturing and market services are derived using a CES production function, where the capital/labor ratio is sensitive to relative factor prices. The incorporation of a structural Phillips curve mechanism in the wage bargaining mechanism introduces further relative price effects. The approach the authors adopted with respect to identification of the structural parameters was that of economic intuition complementing estimation where possible, and calibration according to stylized facts in other cases.

Hermin CR model and its variants have been used in a number of different studies and policy experiments:

- In the original paper Kejak and Vavra (1999a) used the model to study key issues in macroeconomics of transition from centrally planned to market-based economy with the analysis of possible development scenarios and the assessment of related medium-growth prospects and the scope for public policy aimed potentially at facilitating adjustment to EU membership.
- Kejak, Vavra (1999b) draw on the previous modeling research and enrich the Hermin CR model with endogenous mechanisms allowing government spending to affect total factor productivity growth through human capital and infrastructure investment as well as specific cost-saving government subsidies to enterprises. Using these mechanisms, the authors explore possible implications of disbursement of the EU Structural Funds on the convergence prospects of the Czech economy under various scenarios: the first projects the pattern of disequilibrium wage setting from mid 1990s into the future, while the second looks at the consequences of labor market reform. The other scenarios highlight some of the differences between policy strategies based on indigenous versus FDI-driven export-led growth.
- The latter theme was further developed by Barry et al (2003) who, studying the convergence options of the Czech economy, argue that processes that will drive the next stage of the Czech transition are likely to be similar to those promoting real convergence in the countries of the EU periphery. Their model simulations explore some key policy issues facing CEE-country decision-makers: labour market reforms, disinflation and industrial development. In particular, they show i) how the Czech wage-setting behaviour of mid 1990s could threaten the convergence prospects, if continued in the future, ii) how degree of wage indexation affects the real costs associated with necessary disinflation strategies, arguing that exchange rate lead depreciation is likely to be superior to fiscal contraction, iii) the differences between convergence process induced by FDI lead growth and indigenous industries acquiring the necessary technology and experience.
- Finally, the Hermin model was employed on several occasions as a consistency check on medium-term macro economic scenarios presented in the Pre-Accession Economic Programs of the Czech Republic, as well as for internal evaluation purpose in the Czech National Bank.<sup>13</sup>

Fidrmuc and Fidrmuc (2000) also discuss the implications of accession of the Czech Republic to the European Union using an econometric model. First, they estimate the potential growth in the enlargement and the non-enlargement scenarios. Then, they provide a structural forecast of GDP components. The GDP growth was forecasted to accelerate mildly in the accession scenario, following a cyclical pattern (recession 1998 – 1999, recovery 2000 – 2003, boom 2004 – 2007, and a soft landing in the following years), while the non-accession scenario would extend the 1998 recession until 2005.

Barrel et al. (2004) use a set of national macro econometric models to study policy choices facing the EU candidate countries: Poland, Hungary, the Czech Republic, Slovenia and Es-

---

<sup>13</sup> See e.g. the Pre-Accession Economic Programs of the Czech Republic 2001, 2002, downloadable at the official Ministry of Finance website <http://www.mfcr.cz>

tonia. The models allow for endogenous growth, and they have been incorporated into an existing global econometric model (NiGEM). This allows long-term projections to be made consistently with expected developments in other economies and allows full feedbacks with the rest of the world so that impacts on existing EU members as well as the candidate countries can be analyzed. The authors investigate the effects of openness and foreign investment on productivity and growth that have played a particularly important role. The authors also analyze different policies towards growth and the enhancement of technology transfer in the context of the EU accession and integration. Unlike some other approaches (e.g. Hermin based, or Barry et al., 2003), Barrell et al. use high frequency data (relying on panel data techniques) and explicitly multi-country set-up.

In contrast to econometric approaches, Kejak, Seiter, Vavra (2004) and Kejak and Vavra (2002) use the results from endogenous growth models to study the impact of the EU accession on the speed of convergence. They examine qualitatively and quantitatively the potential effect of the accession on the development of several Central and Eastern European (CEE) countries (the Czech Republic, Hungary, and Poland). They model the accession process as progressive opening of the economy in trade and capital flows, and as a massive technological transfer that enables fast technological catch-up with the technological frontier of the advanced countries. The authors build a small open economy version of the two-sector endogenous growth model of the Uzawa-Lucas style with knowledge diffusion and calibrate it to stylized facts of the economic development during the accession process in the EU periphery countries. They then apply the model to CEE countries, making predictions about their convergence under several alternative scenarios.

---

## THE DATABASE FOR THE HCZ5 MODEL

### 3.1 INTRODUCTION

The construction of a database to serve in the design and implementation of a macro model will be heavily influenced by the exact nature of the model. If the model is to be of fairly simple and aggregate form, the database will be correspondingly simple. But if the model is intended to have a high level of sectoral and other disaggregation, then the database will need to become larger and more complex.

As discussed in the introductory section, the main purpose of the HERMIN framework is to have a macro model that pays special attention to the production side of the economy. To that end, we seek to build a database of time series that is adequate for a range of possible levels of sectoral aggregation, ranging from one production sector (as in many simple Keynesian income-expenditure models) to many production sectors.

There is a temptation to construct the model database simply by computerising from published sources everything that appears to be needed. But this can be quite inefficient and the construction of the database is better undertaken in two separate stages. In the first stage we attempt to computerise the necessary and sufficient data from original sources, which are usually spread across many printed publications. We refer to these series as “raw” (or sometimes “basic”) data, in the sense that they need to be physically extracted from primary or secondary published data sources, but are sufficient to generate all remaining data series.

There are two main reasons for making this distinction. First, we wish to keep to a minimum the amount of data that actually have to be extracted and computerised. In that way the task of keeping the database up-to-date is also made easier. Second, we wish to ensure that the data are consistent with the identity equations in the model system, or that we are able to define “generated” variables as combinations of other “raw” or previously “generated” variables. This might seem to be an unnecessary precaution, since published data are usually carefully checked by the originating statistical agencies. But situations can arise where adjustment errors or missing components in adding-up identities produce discrepancies.

In the second stage we take the “raw” or “basic” data series and use them to generate all the remaining data series needed for the model. For example, if we have household consumption in current prices (CONSV) and the price deflator of consumption (PCONS), we can generate data for household consumption in constant base-year prices (CONS) as follows:

$$\text{CONS} = \text{CONSV}/\text{PCONS}$$

Similarly, if we have all the individual components of GDP on an expenditure basis in current prices (household consumption (CONSV), public consumption (GV), total investment (IV), exports (XV) and imports (MV)), we can generate total GDP on an expenditure basis, in current prices, as follows:

$$GDPEV = CONSV + GV + IV + XV - MV$$

Finally, we may wish to combine the data in a complex way. For example, if we had “raw” data for investment by the manufacturing sector (IT), we could generate a capital stock variable,  $KT$ , using the so-called perpetual inventory formula, as follows:

$$KT_t = IT_t + (1-\delta) KT_{t-1}$$

Since the TSP batch files that implement stages one and two of the database preparation are vital parts of the model support system, we describe each briefly in the following two subsections.

### 3.2 STAGE 1: THE “RAW” DATA FOR THE CZECH HCZ5 MODEL

The input of the “raw” or “basic” data is carried out using three separate spreadsheets (or XLS files), as shown in Table 3.2.1 below:

Table 3.2.1:  
Input of “raw” data series for HCZ5 database

[1]	HCZ_BASIC_DATA.XLS	Data from Czech Republic sources
[2]	NiGEM_World_Production.XLS	World output data (NiGEM)
[3]	World_Prices.XLS	World price data (NiGEM)

The first XLS file (HCZ\_BASIC\_DATA.XLS) contains all the necessary data that have been computerised from Czech national sources. This Excel file is too large to reproduce in the present report, but is attached on the CD-ROM that accompanies the report. The first worksheet of the file HCZ\_BASIC\_DATA.XLS contains the “basic” data needed for a 10-sector Czech HERMIN model. The second worksheet contains the “basic” dataset needed for the standard 4-sector HERMIN model. Each of these two worksheets draws data from the remaining worksheets contained in HCZ\_BASIC\_DATA.XLS, which are organised into topics such as WAGES (containing sectoral wage rate data); Employment (containing sectoral employment data), etc.

The second XLS file in Table 3.2.1 (NiGEM\_World\_Production.XLS) contains data that have been extracted from the NiGEM world model database that is produced by the London-based National Institute for Economic and Social Research (NIESR). The third XLS file (World\_Prices.XLS) is also extracted from NiGEM, and contains data on world prices.

In order to collate all the required “basic” data into a format that can be read by TSP, we gather the data together into a simplified form in four XLS files as follows (Table 3.2.2):

Table 3.2.2:  
**HCZ5 XLS files for input to data generating process**

[1]	CZBasicDAT.XLS	Data for 4-sector HERMIN model (T, N, A and G)
[2]	CZBandCDAT.XLS	Data for Czech building & construction sector (BC)
[3]	World_Production.XLS	World production data (annualised)
[4]	World_Prices.XLS	World price data (annualised)

All remaining data for a 5-sector Czech HERMIN model can be derived from these four XLS files. We now describe how that generation is carried out.

### 3.3 STAGE 2: THE “GENERATED” DATA FOR THE CZECH HCZ5 MODEL

The “raw” data form a small part of the total database. In this section we describe how the remainder of the data are generated from the “raw” data as well as from previously generated data. The full details of these operations are presented in Annex C.1 (as HERDATA\_HCZ5.TSP in subsection C.1.5), which consists of a listing of a TSP batch file made up of statements of the following general form:

Left hand side variable = f(“basic” data, “generated” data)

A special case of this is the statement of form:

“basic” data variable = “basic” data variable (e.g., CONSV = CONSV)

A command of the above form has the effect of simply storing the “basic” data variable (e.g., CONSV) in the TSP binary database HCZ5DB.TLB. More generally, the commands in the TSP batch file HERDATA\_HCZ5.TSP (as fully listed in Annex A3.1.5) are designed to be executed in sequence. In other words, any “generated” data that occurs on the right hand side of an equation must have appeared on the left hand side of an earlier statement. So, great care must be exercised if any changes or extensions are made to the HERDATA\_HCZ5.TSP file.

In what follows we provide a short description of the structure of the HERDATA\_HCZ5.TSP batch file. The TSP file is heavily and clearly annotated with explanatory comments so that it can be examined directly by the interested reader.

At the start of the file HERDATA\_HCZ5.TSP, the four XLS data files containing “basic” data (as listed in Table 3.2.2 above) are read in (having been stored as TSP binary files using the TSP batch files listed in Annex 3.1), and the output file (HCZ5DB.TLB) is defined. This latter “binary” data file is designed to contain the complete set of data needed to set up the HCZ5 HERMIN model.

After some introductory definitions (mainly of time trend variables), the file then processes the international output and price data, and defines a measure of the level of activity in the world economy that reflects the importance of the countries as Czech trading partners (i.e., the aggregate world output (OW) variable and the aggregate world price variable (PWORLD)).

The program then works through the five sectors of the HERMIN HCZ5 model, in the following order: manufacturing (T); Building and construction (BC); Market services (MS); Agriculture (A); and non-market (or government) services (G). In every case, the limited number of “basic” data variables are read in and stored, and a series of complex data generations take place.

The demographic and labour force data are then processed, and various measures of unemployment derived. The basic measure of the unemployment rate (UR) used in HERMIN is that given by the ILO/LFS approach, although we also include two other administrative or “entitlements-based” definitions.

The next section of the file HERDATA\_HCZ5.TSP generates all the necessary data on GDP on an expenditure basis. A full treatment of expenditure is available in the HERMIN model, including private consumption (CONS), public consumption (G), investment (I), stock changes (DS), exports (X) and imports (M). It should be noted that total investment is further disaggregated on the supply-side of the model into investment activities carried out by the five production sectors used in the HERMIN model (see above).

The next section of HERDATA\_HCZ5.TSP deals with government revenue and expenditure activities, and derives the public sector borrowing requirement and accumulates the national debt.

The final section of HERDATA\_HCZ5.TSP deals with the income side of the Czech national accounts, and derives the measure of real household disposable income (YRPERD) that is used to drive household consumption (CONS).

The concluding part of the data side of the HERMIN model concerns the assembly of the data into all the model “exogenous” variables and “endogenous” variables. The “endogenous” variables are those whose values will be derived as outputs from the HERMIN model. The “exogenous” variables are the independent variables whose values can be set externally by the model users. Examples of the latter are public employment, tax rates, and world variables (which are taken from international sources).<sup>14</sup>

---

<sup>14</sup> The HERMIN endogenous variables are split into two separate groups, since it is necessary to keep the number of columns in the XLS spreadsheet below 256, the upper limit imposed by Excel.

### **3.4 CONCLUDING REMARKS ON DATA ISSUES**

The preparation of the database to support the construction of the Czech HERMIN model is a major activity. In terms of the subsequent stages of the development of the model, the database is used as follows:

- i. Calibration of the behavioural equations in the model, using econometric techniques;
- ii. Definition of the historical “within-sample” data set for the model, prior to using the model to simulate beyond the data termination year (2004 at present) in the preparation of forecasts.

The use of the database with the econometric program is very simple, since one command of the form “IN HCZ5DB” gives the user immediate access to all the data contained in the database file HCZ5DB.TLB. However, the data are also available in XLS format, in the files HCZ5EXOG.XLS, HCZ5ENDO1.XLS and HCZ5ENDO2.XLS, being the exogenous and endogenous variables, respectively. However, it should be noted that while the three XLS files contain all the data used in the actual model, HCZ5, the TSP database, HCZ5DB.TLB also contains many ancillary variables that are useful for data checking, etc., but are not used in the model itself.



---

## THE HERMIN MODELLING FRAMEWORK

### 4.1 INTRODUCTION

The reform and expansion of EU regional investment programmes into the so-called *Community Support Frameworks* (CSFs) in the late 1980s presented the EC as well as domestic policy makers and analysts with major challenges. Although the CSF investment expenditures were very large, this in itself was not a problem for policy design or analysis.<sup>15</sup> Indeed, evaluating the macroeconomic impact of public expenditure initiatives had been an active area of work since quantitative models were first developed in the 1930s (Tinbergen, 1939).<sup>16</sup> What was special about the CSF was its declared goal to implement policies whose explicit aim was to transform and modernise the underlying structure of the beneficiary economies in order to prepare them for greater exposure to international competitive forces within the Single Market and EMU. Thus, CSF policies moved far beyond a conventional demand-side stabilization role, being aimed rather at the promotion of structural change, accelerated long-term growth and real cohesion through mainly supply-side mechanisms.

The new breed of macroeconomic models of the late 1980s had addressed the theoretical deficiencies of conventional Keynesian econometric models that had precipitated the decline of modelling activity from the mid-1970s (Klein, 1983; Helliwell *et al*, 1985). However, policy makers and policy analysts were still faced with the dilemma of having to use conventional economic models, calibrated using historical time-series data, to address the consequences of future structural changes. The Lucas critique was potentially a serious threat to such model-based policy impact evaluations (Lucas, 1976). In particular, the relationship between public investment policies and private sector supply-side responses - matters that were at the heart of the CSF - were not very well understood or articulated from a modelling point of view.

The revival of the study of growth theory in the mid-1980s provided some guidelines to the complex issues involved in designing policies to boost a country's growth rate, either permanently or temporarily, but was more suggestive of mechanisms than of magnitudes (Barro and Sala-y-Martin, 1995; Jones, 1998). Furthermore, the available empirical growth studies tended to be predominantly aggregate and cross-country rather than disaggregated and country-specific.<sup>17</sup> Yet another complication facing the designers and analysts of the CSF

---

<sup>15</sup> Typically, CSF expenditures range from about 1 percent of GDP annually in the case of Spain to over 3 per cent in the case of Greece. The macro consequences are clearly important.

<sup>16</sup> Tinbergen's early contribution to the literature on the design and evaluation of supply-side policies still reads remarkably well after almost 40 years (Tinbergen, 1958).

<sup>17</sup> Fischer, 1991 suggested that identifying the determinants of investment, and the other factors contributing to growth, would probably require a switch away from simple cross-country regressions to time series studies of individual countries.

was that the four main beneficiary countries - Greece, Ireland, Portugal and Spain - were on the geographical periphery of the EU, thus introducing spatial issues into their development processes. With advances in the treatment of imperfect competition, the field of economic geography (or the study of the location of economic activity) had also revived during the 1980s (Krugman, 1995; Fujita, Krugman and Venables, 1999). But the insights of the new research were confined to small theoretical models and seldom penetrated up to the type of large-scale empirical models that are typically required for realistic policy analysis.

## 4.2 APPROACHES TO POLICY MODELLING

The Keynesian demand-driven view of the world that dominated macro modelling prior to the mid-1970s was exposed as being entirely inadequate when the economies of the OECD were hit by the supply-side shocks of the crisis-racked 1970s (Blinder, 1979). From the mid-1970s onwards, attention came to be focused on issues of cost competitiveness as an important ingredient in output determination, at least in highly open economies. More generally, the importance of the manner in which expectation formation was handled by modelers could no longer be ignored, and the reformulation of empirical macro models took place against the background of a radical renewal of macroeconomic theory in general (Blanchard and Fischer, 1990).

The Czech Republic HERMIN model framework draws on some aspects of the above revision and renewal of macro economic modelling. The origins of the HERMIN model lay in the complex multi-sectoral HERMES model that was developed by the European Commission from the early 1980s (d'Alcantara and Italianer, 1982). HERMIN was initially designed to be a small-scale version of the HERMES model framework in order to take account of the very limited data availability in the poorer, less-developed EU member states and regions on the Western and Southern periphery (i.e., Ireland, Northern Ireland, Portugal, Spain, the Italian *Mezzogiorno*, and Greece).<sup>18</sup> A consequence of the lack of detailed macro-sectoral data and of sufficiently long time-series that had no structural breaks was that the HERMIN modelling framework needed to be based on a fairly simple theoretical framework that permitted inter-country and inter-region comparisons and that facilitated the selection of key behavioural parameters in situations where sophisticated econometric analysis was impossible.

An example of a useful theoretical modelling framework is one that treats goods as being essentially internationally tradeable (T) and non-tradeable (N) (see Lindbeck, 1979). Drawing on this literature, relatively simple versions of the model can be used to structure debates that take place over macroeconomic issues in small open economies (SOEs) and regions. The HERMIN model shows how an empirical model can be constructed that incorporates many of these insights.

---

<sup>18</sup> After German unification, the former East Germany was added to the list of "lagging" EU regions.

### 4.3 ONE-SECTOR AND TWO-SECTOR SMALL-OPEN-ECONOMY MODELS

In the one-sector model all goods are assumed to be internationally tradeable, and all firms in the small open economy (SOE) are assumed to be perfect competitors. This has two implications;

- a) Goods produced domestically are perfect substitutes for goods produced elsewhere, so that prices (mediated through the exchange rate) cannot deviate from world levels;
- b) Firms are able to sell as much as they desire to produce at going world prices. It rules out Keynesian phenomena right from the start.

The 'law of one price', operating through goods and services arbitrage, therefore ensures that

$$(4.1) \quad p_t = ep_t^*$$

where  $e$  is the price of foreign currency and  $p_t^*$  is the world price. Under a fixed exchange rate this means that in this simple stylised model, domestic inflation is determined entirely abroad. The second implication of perfect competition is that the SOE faces an infinitely elastic world demand function for its output, and an infinitely elastic world supply function for whatever it wishes to purchase.

A major weakness of the one-sector model as a description of economic reality, even for as open an economy as that of the Czech Republic, is that the assumption (implied by perfect competition) that domestic firms can sell all they desire to produce at going world prices is patently unrealistic. For example, to take account of the phenomenon that world demand exerted an impact on Irish output independent of its impact on price, Bradley and Fitz Gerald (1988 and 1990) proposed a model in which all tradeable-sector production is assumed to be carried out by internationally footloose companies (MNCs) where price-setting decisions are independent of the SOE's factor costs. When world output expands, MNCs expand production at all their production locations. However, the proportion of MNC investment located in any individual SOE depends on the relative competitiveness of the SOE in question. This allows SOE output to be determined both by domestic factor costs and by world demand. However, since SOE demand is tiny relative to world demand, it plays no role in the MNC's output decisions.

Another weakness of the one-sector SOE model is that, as already noted, government spending is precluded from having any positive effects. However, most studies of Irish employment and unemployment conclude that the debt-financed fiscal expansion of the late-1970s did indeed boost employment and reduce unemployment, albeit at the expense of requiring very contractionary policies over the course of the whole 1980s (Barry and Bradley (1991)).

To address these criticisms, one can add an extra sector, the non-tradeable (N) sector, to the one sector model. Output and employment in tradeables (T) continues to be determined as before, while the non-tradeables (N) sector operates more like a closed economy model. The interactions between the two sectors prove interesting however. For example, the price of non-tradeables is determined by the interaction of supply and demand for these goods.

#### 4.4 THE STRUCTURE OF THE HERMIN MODEL

We now discuss some practical and empirical implications that have to be taken into account when designing and building a small empirical model of a typical European peripheral economy like the Czech Republic, building on the insights of the two-sector SOE model. Since the model is being constructed in order to analyse medium-term policy impacts, basically there are three requirements which it should satisfy:

- (i) It must be disaggregated into a small number of crucial sectors which allows one at least to identify and treat the key sectoral shifts in the economy over the years of development.
- (ii) It must specify the mechanisms through which a “cohesion-type” economy is connected to the external world. The external (or world) economy is a very important direct and indirect factor influencing the economic growth and convergence of the lagging EU and CEE economies, through trade of goods and services, inflation transmission, population emigration and inward foreign direct investment.
- (iii) It must recognise that a possible conflict may exist between actual situation in the country, as captured in a HERMIN model calibrated with the use of historical data, and the desired situation towards which the cohesion or transition economy is evolving in an economic environment dominated by EMU and the Single European Market.

The HERMIN model framework focuses on key structural features of a cohesion-type economy:

- a) The degree of economic openness, exposure to world trade, and response to external and internal shocks;
- b) The relative sizes and features of the traded and non-traded sectors and their development, production technology and structural change;
- c) The mechanisms of wage and price determination;
- d) The functioning and flexibility of labour markets with the possible role of international and inter-regional labour migration;
- e) The role of the public sector and the possible consequences of public debt accumulation, as well as the interactions between the public and private sector trade-offs in public policies.

To satisfy these requirements, the basic HERMIN framework originally had four sectors: manufacturing (a mainly traded sector), market services (a mainly non-traded sector, that included building and construction), agriculture and government (or non-market) services (see Kejak and Vavra, 1998; Barry et al, 2003). In the present extension of the HERMIN framework for the Czech Republic, we further disaggregate the aggregate market services sector (N) into two separate sub-sectors: building and construction (BC) and the rest of mar-

ket services (MS).<sup>19</sup> Given the data restrictions that often face modellers in cohesion and transition economies, this is as close an empirical representation of the traded/non-traded disaggregation as we are likely to be able to implement in practice. Although agriculture also has important traded elements, its underlying characteristics demand special treatment. Similarly, the government (or non-market) sector is non-traded, but is best formulated in a way that recognises that it is mainly driven by policy instruments that are available – to some extent, at least – to policy makers.<sup>20</sup>

The structure of the model framework can be best thought as being composed of three main blocks: a supply block, an absorption block and an income distribution block. Obviously, the model functions as integrated systems of equations, with interrelationships between all their sub-components. However, for expositional purposes we describe the HERMIN modelling framework in terms of the above three sub-components, which are schematically illustrated in Figure 4.4.1.

Conventional Keynesian mechanisms are at the core of any HERMIN model. Expenditure and income distribution sub-components generate the standard income-expenditure mechanisms. But the model also has many neoclassical features. Thus, output in manufacturing is not simply driven by demand. It is also influenced by price and cost competitiveness, where firms seek out minimum cost locations for production (Bradley and Fitz Gerald, 1988). In addition, factor demands in manufacturing and market services are derived using a CES production function constraint, where the capital/labour ratio is sensitive to relative factor prices. The incorporation of a structural Phillips curve mechanism in the wage bargaining mechanism introduces further relative price effects.

The model handles the three complementary ways of measuring GDP in the national accounts, on the basis of output, expenditure and income. On the output basis, HERMIN disaggregates five sectors: manufacturing (OT), building and construction (OBC), market services (OMS), agriculture (OA) and the public (or non-market) sector (OG). On the expenditure side, HERMIN disaggregates into the conventional five components: private consumption (CONS), public consumption (G), investment (I), stock changes (DS), and the net trade balance (NTS).<sup>21</sup> National income is determined on the output side, and disaggregated into private and public sector elements.

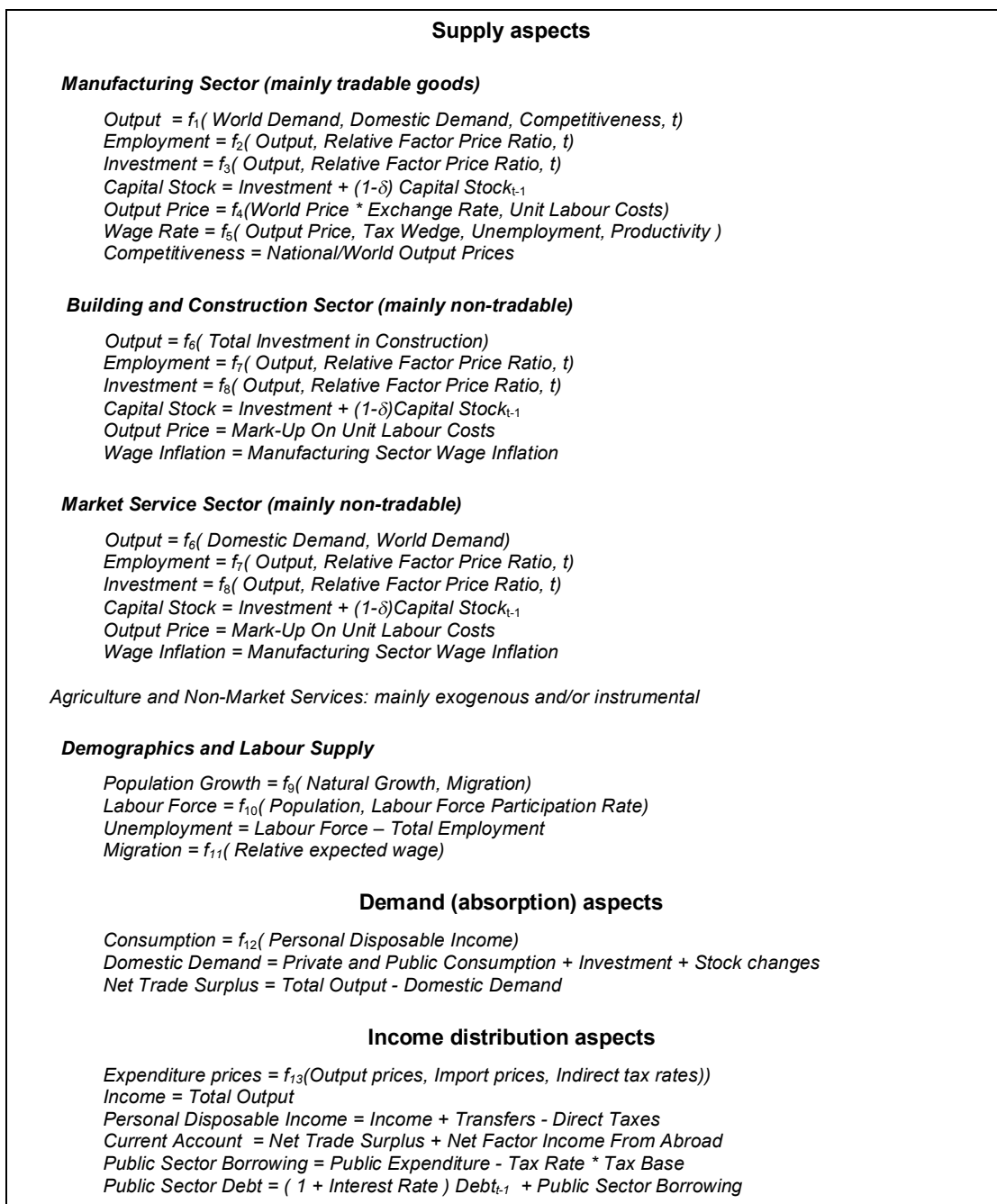
---

19 The separate treatment of building and construction (BC) is required since large proportion of the Structural Funds involve investment in physical infrastructure. In NSRF 2007-2013, this proportion can be as high as 70 per cent of the total.

20 Elements of public policy are endogenous, but we handle these in terms of policy feed-back rules rather than behaviourally.

21 The traded/non-traded disaggregation implies that only a net trade surplus is logically consistent. Separate equations for exports and imports could be appended to the model, but would function merely as conveniently calculated “memo” items that were not an essential part of the model’s behavioural logic.

Figure 4.4.1:  
The HERMIN Model Schema



#### KEY EXOGENOUS VARIABLES

*External:* World output and prices; exchange rates; interest rates;

*Domestic:* Public expenditure; tax rates.

Since all elements of output are modelled, the output-expenditure identity is used to determine the net trade surplus/deficit residually. The output-income identity is used to determine corporate profits residually. Finally, the equations in the model can be classified as behavioural or identity. In the case of the former, economic theory and calibration to the data are used to define the relationships. In the case of identities, these follow from the logic of the national accounts, but have important consequences for the behaviour of the model as well.

## 4.5 THE SUPPLY SIDE OF THE HERMIN MODEL

### (i) OUTPUT DETERMINATION

The theory underlying the macroeconomic modelling of a small open economy requires that the equation for output in a mainly traded sector reflects both purely supply side factors (such as the real unit labour costs and international price competitiveness), as well as the extent of dependence of output on a general level of world demand, e.g. through operations of multinational enterprises, as described by Bradley and Fitz Gerald (1988). By contrast, domestic demand should play only a limited role in a mainly traded sector, mostly in terms of its impact on the rate of capacity utilisation. However, manufacturing in any but extreme cases includes a large number of partially sheltered subsectors producing items that are effectively (or partially) non-traded. Hence, we would expect domestic demand to play a more substantial role in this sector, possibly also influencing capacity output decisions of firms. HERMIN posits a hybrid supply-demand equation of the form:

$$(4.2) \quad \log(OT) = a_1 + a_2 \log(OW) + a_3 \log(ULCT / POT) \\ + a_4 \log(FDOT) + a_5 \log(POT / PWORLD) + a_6 t$$

where  $OW$  represents the crucial external (or world) demand, and  $FDOT$  represents the influence of domestic absorption. We further expect  $OT$  to be negatively influenced by real unit labour costs ( $ULCT/POT$ ) and the relative price of domestic versus world goods ( $POT/PWORLD$ ).

A fairly simple form of the building and construction output equation ( $OBC$ ) and the market service sector output equation ( $OMS$ ) is specified in HERMIN:

$$(4.3a) \quad \log(OBC) = a_1 + a_2 \log(IBCTOT) + a_3 \log(ULCBC/POBC) + a_4 t$$

$$(4.3b) \quad \log(OMS) = b_1 + b_2 \log(FDOMS) + b_3 \log(ULCMS/POMS) + b_4 t$$

where  $IBCTOT$  is total investment in building and construction by all the other four sectors, and  $FDOMS$  is a measure of domestic demand. The variables  $ULCBC$  and  $ULCMS$  are unit labour costs in building and construction and market services, respectively, and are deflated using the sectoral GDP deflators ( $POBC$  and  $POMS$ , respectively). Output in agriculture is modelled very simply as an inverted labour productivity equation;

$$(4.4) \quad \log(OA/LA) = a_0 + a_1 t$$

And output in the public sector is determined by public sector employment, which is a policy instrument.

## (ii) FACTOR DEMANDS

Macro models usually feature production functions of the general form:

$$(4.5) \quad Q = f(K, L)$$

(where Q represents output, K capital stock and L employment), without output being actually determined by this relationship. We have seen above that manufacturing output is determined in HERMIN by a mixture of world and domestic demand, together with price and cost competitiveness terms. Having determined output in this way, the role of the production function is to constrain the determination of factor demands in the process of cost minimisation that is assumed. Hence, given Q (determined as above in a hybrid supply-demand relationship), and given (exogenous) relative factor prices, the factor inputs, L and K, are determined by the production function constraint. Hence, the production function operates in the model as a technology constraint and is only indirectly involved in the determination of output. It is partially through these interrelated factor demands that the longer run efficiency enhancing effects of policy and other shocks like the EU Single Market and the Structural Funds are believed to operate.

Ideally, a macro policy model should allow for a production function with a fairly flexible functional form that permits a variable elasticity of substitution. As the recent experience of several peripheral countries, especially Ireland, suggests (Bradley *et al.*, 1995), the issue is important. When an economy opens and becomes progressively more influenced by activities of foreign-owned multinational companies, the traditional substitution of capital for labour following an increase in the relative price of labour need no longer happen to the same extent. The internationally mobile capital may choose to move to a different location than seek to replace costly domestic labour. In terms of the neoclassical theory of firm, the isoquants get more curved as the technology moves away from a Cobb-Douglas towards a Leontief type.

Since the Cobb-Douglas production function is too restrictive, we use the CES form of the added value production function and impose it on the manufacturing (T), building and construction (BC) and market service (MS) sectors. Thus, in the case of manufacturing;

$$(4.6) \quad OT = A \exp(\lambda t) \left[ \delta \{LT\}^{-\rho} + (1 - \delta) \{KT\}^{-\rho} \right]^{-\frac{1}{\rho}},$$



In this equation,  $OT$ ,  $LT$  and  $KT$  are added value, employment and the capital stock, respectively,  $A$  is a scale parameter,  $\rho$  is related to the constant elasticity of substitution,  $\delta$  is a factor intensity parameter, and  $\lambda$  is the rate of Hicks neutral technical progress.

In both the manufacturing and market service sectors, factor demands are derived on the basis of cost minimisation subject to given output, yielding a joint factor demand equation system of the schematic form:

$$(4.7a) \quad K = g_1 \left( Q, \frac{r}{w} \right)$$

$$(4.7b) \quad L = g_2 \left( Q, \frac{r}{w} \right)$$

where  $w$  and  $r$  are the cost of labour and capital, respectively.<sup>22</sup>

Although the central factor demand systems in the manufacturing (T), building and construction (BC) and market services (MS) sectors are functionally identical, they will have different estimated parameter values and two further crucial differences.

- (a) First, output in the traded sector (OT) is driven by world demand (OW) and domestic demand (FDOT), and is influenced by international price competitiveness (PCOMPT) and real unit labour costs (RULCT). In the non-traded sectors, on the other hand, output (OBC and OMS) are driven purely by domestic demand (IBCTOT and FDOMS, respectively), with only a very limited possible role for world demand (OW), which we exclude. This captures the essential difference between the neoclassical-like tradable sector and the sheltered Keynesian non-traded sector.<sup>23</sup>
- (b) Second, the output price in the manufacturing (T) sector is partially externally determined by the world price. In the market services sectors (BC and MS), the producer prices are a pure mark-up on costs. This puts another difference between the partially price taking tradable sector and the price making non-tradable sector.

The modelling of factor demands in the agriculture sector is treated very simply in HERMIN, but can always be extended in later versions as satellite models, where the institutional aspects of agriculture are fully included. GDP in agriculture is modelled as an inverted productivity relationship (see above). Labour inputs into agriculture are modelled as a (declining) time trend, and not as part of a neo-classical optimising system, as in manufacturing and market services. The capital stock in agriculture is modelled as a trended capital/output ratio.

<sup>22</sup> The above treatment of the capital input to production in HERMIN is influenced by the earlier work of d'Alcantara and Italianer, 1982 on the vintage production functions in the HERMES model. The implementation of a full vintage model was impossible, even for the four EU cohesion countries. A hybrid putty-clay model is adopted in HERMIN (Bradley, Modesto and Sosvilla-Rivero, 1995).

<sup>23</sup> When we refer to a sector as being "non-traded", we mean that its output is only sold locally and is not exported, nor is it subject to direct competition from imported substitutes. Many service sector activities fall into this category.

Finally, in the non-market service sector, factor demands (i.e., numbers employed and fixed capital formation) are exogenous instruments and can be varied by policy makers, subject to fiscal solvency criteria.

### (iii) SECTORAL WAGE DETERMINATION

Modelling of the determination of wages and prices in HERMIN is influenced by the so-called Scandinavian model (Lindbeck, 1979). Thus, the behaviour of the manufacturing (T) sector is assumed to be dominant in relation to wage determination. The wage inflation determined in the manufacturing sector are passed through to the down-stream “sheltered sectors, i.e., building and construction, market services, agriculture and non-market services, in equations of the form:

$$(4.8a) \quad \text{WBCDOT} = \text{WTDOT} + \text{stochastic error}$$

$$(4.8b) \quad \text{WMSDOT} = \text{WTDOT} + \text{stochastic error}$$

$$(4.8c) \quad \text{WADOT} = \text{WTDOT} + \text{stochastic error}$$

$$(4.8d) \quad \text{WGDOT} = \text{WTDOT} + \text{stochastic error}$$

where WTDOT, WBCDOT, WMSDOT, WADOT and WGDOT are the wage inflation rates in manufacturing, building and construction, market services, agriculture and non-market services, respectively.

In the crucial case of manufacturing, wage rates are modelled as the outcome of a bargaining process that takes place between organised trades unions and employers, with the possible intervention of the government. Formalised theory of wage bargaining points to four paramount explanatory variables (Layard, Nickell and Jackman (LNJ), 1990):

- a) *Output prices*: The price that the producer can obtain for output clearly influences the price at which factor inputs, particularly labour, can be purchased profitably.
- b) *The tax wedge*: This wedge is driven by total taxation between the wage denominated in output prices and the take home consumption wage actually enjoyed by workers.
- c) *The rate of unemployment*: The unemployment or Phillips curve effect in the LNJ model is a proxy for bargaining power. For example, unemployment is usually inversely related to the bargaining power of trades unions. The converse applies to employers.
- d) *Labour productivity*: The productivity effect comes from workers' efforts to maintain their share of added value, i.e. to enjoy some of the gains from higher output per worker.

A simple log-linear formulation of the LNJ-type wage equation might take the following form:

$$(3.9) \quad \text{Log(WT)} = a_1 + a_2 \log(\text{POT}) + a_3 \log(\text{WEDGE}) + a_4 \log(\text{LPRT}) + a_5 \text{UR}$$

where WT represents the wage rate, POT the price of manufactured goods, WEDGE the tax “wedge”, LPRT labour productivity and UR the rate of unemployment.

#### (iv) DEMOGRAPHICS AND LABOUR SUPPLY

In a medium-term model like HERMIN, population growth can be endogenised through a “natural” growth rate, corrected for net additions or subtractions due to migration. Net migration flows can then be modelled using a standard Harris-Todaro approach that drives migration by the relative attractiveness of the local (or national) and international labour markets, where the latter can be proxied by an appropriate destination of migrants, e.g., the UK, Germany, Ireland, etc. in the case of the Czech Republic (Harris and Todaro, 1970).<sup>24</sup> Attractiveness can be measured in terms of the relative expected wage, i.e., the product of the probability of being employed by the average wage in each region. In the present version of the Czech model (HCZ5) we have left population exogenous, and ignore migration. But these mechanisms can be considered at a later stage, if they prove to be important.

Finally, the labour force participation rate (i.e., LFPR, or the fraction of the working-age population (NWORK) that participates in the labour force (LF)), can be modelled as a function of the unemployment rate (UR) and a time trend that is designed to capture slowly changing socio-economic and demographic conditions.

$$(4.10) \quad \text{LFPR} = a_1 + a_2 \text{UR} + a_3 t$$

### 4.6 ABSORPTION IN HERMIN

#### (i) PRIVATE CONSUMPTION

Household consumption represents by far the largest component of aggregate demand in most developed economies. The properties of the consumption function play a central role in transmitting the effects of changes in fiscal policy to aggregate demand via the Keynesian multiplier. The determination of household consumption is kept simple in the basic HERMIN model, and private consumption (CONS) is determined purely by real personal disposable income (YRPERD).

$$(4.11) \quad \text{CONS} = a_1 + a_2 \text{YRPERD}$$

In other words, households are assumed to be liquidity constrained, in the sense of having very limited access to savings or credit in order to smooth their consumption. In later extensions of the HERMIN model, a more sophisticated approach was adopted.<sup>25</sup>

<sup>24</sup> The poor quality of migration data often makes it very difficult to implement the Harris-Todaro framework, and to calibrate the parameters.

<sup>25</sup> For example, in the Irish HERMIN model, experiments were carried out with hybrid liquidity constrained and permanent income models of consumption. It was found that the long-run properties of the model were relatively invariant to the choice between a hybrid and a pure liquidity con-

As for the remaining elements of absorption, public consumption is determined primarily by public employment, which is a policy instrument. Private investment is determined within three of the four sectors as the investment part of the sectoral factor demand systems. Public investment is a policy instrument. Inventory changes (DS) are modelled using the standard stock-adjustment approach. Finally, in keeping with the guiding spirit of the two-sector small-open-economy model, exports and imports are not modelled explicitly in HERMIN. Instead, the net trade surplus is residually determined from the balance between GDP on an output basis (GDPFC) and domestic absorption (GDA). Hence, to the extent that a policy shock drives up domestic absorption more than output, the net trade surplus deteriorates.

## 4.7 NATIONAL INCOME IN HERMIN

### (i) THE PUBLIC SECTOR

With a view to its future use for policy analysis, HERMIN includes a conventional degree of institutional detail in the public sector. Within total public expenditure, we distinguish public consumption (mainly wages of public sector employees), transfers (social welfare, subsidies, debt interest payments), and capital expenditure (public housing, infrastructure, investment grants to industry). Within public sector debt interest, we would ideally like to distinguish interest payments to domestic residents from interest payments to foreigners, the latter representing a leakage out of GDP through the balance of payments.

One often needs a method of altering public policy within the model in reaction to the economic consequences of any given policy shock. If all the policy instruments are exogenous, this is not possible, although instruments can be changed on the basis of off-model calculations. A solution of the problem by incorporating an "intertemporal fiscal closure rule" has been suggested in Bryant and Zhang, 1994. If it is appropriate, one can include a closure or policy feed back rule in HERMIN, whose task is to ensure that the direct tax rate is manipulated in such a way as to keep the debt/GNP ratio close to an exogenous notional target debt/GNP ratio. A policy feed back rule can be based on the IMF world model, MULTIMOD (Masson *et al.*, 1989), and might take the following form:

$$(4.12) \quad \Delta RGTY P = \alpha \left\{ \frac{(GNDT - GNDT^*)}{GNPV} \right\} - \beta \left\{ \frac{(GNDT - GNDT^*) - (GNDT_{-1} - GNDT_{-1}^*)}{GNPV} \right\}$$

Here, RGTY P is the direct tax rate, GNDT is the total national debt, GNDT\* is the target value of GNDT, GNPV is nominal GNP, and the values of the parameters  $\alpha$  and  $\beta$  are selected in the light of model simulations. The performance of the rule can be quite sensitive to the choice of the numerical values of  $\alpha$ ,  $\beta$ .

---

strained function. However, if a forward looking model of wage income is used, the adjustment properties of the model change radically (Bradley and Whelan, 1997).

**(ii) THE NATIONAL INCOME IDENTITIES<sup>26</sup>**

The income-output identity is used in HERMIN to derive corporate profits. In the actual model, there are various data refinements, but the identity is essentially of the form:

$$(4.13) \quad YC = \text{GDPFCV} - YW$$

where YC is profits, GDPFCV is GDP at factor cost, and YW is the wage bill for the entire economy. Income of the private sector (YP) is determined in a relationship of form:

$$(4.14) \quad YP = \text{GDPFCV} + \text{GTR}$$

where GTR is total public sector transfers to the private sector. Income of the household (or personal) sector (YPER) is defined essentially as:

$$(4.15) \quad \text{YPER} = YP - YCU$$

where YCU is that element of total profits (YC) that is retained within the corporate sector for reinvestment, as distinct from being distributed to households as dividends. Finally, personal disposable income (YPERD) is defined as

$$(4.16) \quad \text{YPERD} = \text{YPER} - \text{GTY}$$

where GTY represents total direct taxes (income and employee social contributions) paid by the household sector. It is the constant price version of YPERD (i.e.,  $\text{YRPERD} = \text{YPERD}/\text{PCONS}$ ) which drives private consumption in the simple Keynesian consumption function:

$$(4.17) \quad \text{CONS} = a_1 + a_2 \text{YRPERD}$$

**(iii) THE MONETARY SECTOR**

There is no explicit monetary sector in the present version of the Czech HERMIN model. Consequently, both the exchange rate and domestic interest rates are treated as exogenous. The nominal “anchor” in such a model is the world price, denominated in foreign currency. Furthermore, the financing of any public sector borrowing is handled in a rudimentary fashion, with any net flow of annual public sector borrowing being simply accumulated into a stock of debt. This lack of a monetary sector is not a very severe restriction in the case of small EU member states who were in the EMS zone and who subsequently joined the euro

---

<sup>26</sup> In the following equations, we use simplified formulations. The actual model equations often include some additional terms (see Annex).

zone, or for CEE countries who operate a currency board. However, in the case of the Czech Republic, which operates an independent monetary policy, we adjust the monetary instruments using other “off-model” information.

---

## CALIBRATING THE HERMIN BEHAVIOURAL EQUATIONS

### 5.1 INTRODUCTION

In the preceding section, we described the Czech Republic HERMIN HCZ5 model as a stylised, compact system of equations. In this section we look in detail mainly at individual behavioural equations from the point of view of the calibration process. We will discuss their functional forms on the basis of the underlying theory and principles that guided us during the actual calibration of each of them, and we will also comment on the numerical values of the parameters obtained by this procedure.

As in the standard HERMIN models (Bradley *et al.*, 1995b), the HERMIN model for The Czech Republic contains over 350 equations, many of which are included to increase the model's transparency and facilitate simulation and policy analysis exercises.<sup>27</sup> The essential core of the model consists of a smaller number of about 29 equations which are behavioural in a strictly economic sense (i.e., empirical versions derived from an underlying theoretical specifications, containing parameters that must be assigned numerical values). These are the equations we will focus on in the following paragraphs.<sup>28</sup>

Before proceeding with the analysis of the individual equations, a few qualifying remarks concerning our approach to calibration are appropriate. As will be apparent from the descriptive material on the Czech database presented in Section 3, the data constraints enable us to work only with about ten annual data observations for the period 1995-2004 at best, since the data prior to 1995 are incomplete and not very reliable. The small number of observations available prevented us from undertaking the sophisticated econometric estimation and hypothesis testing techniques commonly used to calibrate macro models.

---

<sup>27</sup> For example, the wage in manufacturing (WT) is determined in a behavioural equation. But the inflation rate (WTDOT) is determined in an identity, merely to facilitate the examination of simulation output.

<sup>28</sup> The distinction between a "behavioural" equation and an "identity" equation tends to vanish when the model is simulated as an integrated system. Within the overall system, every equation is important. But the "behavioural" equations are treated as a special case, since we need to have recourse to theory and econometrics to assign functional forms and parameter values.

Three different approaches to model calibration (or estimation) are used in the literature of modelling in the transition economies of the CEE region:

**(i) Extending the data sample over different economic regimes**

An example of this approach is the Polish W8-2000 model, where data for the period 1960-1998 are used (Welfe, Welfe, Florczak and Sabanty, 2002). The apparent advantage is that this provides 39 annual observations and facilitates econometric hypothesis testing and estimation. The serious disadvantage is that the extended data sample covers three very different economic regimes: the era of Polish Communist economic planning; the years immediately following the collapse of the Communist economic system; and the era of rapid recovery and growth that followed the post-Communist collapse. We have serious reservations about using this approach for the Czech Republic, and propose to use only the 1995-2004 data sample that we incorporated into the HCZ5 model database.

**(ii) The Panel data approach**

This is the approach used within the CEE models contained in the NIGEM model of the world economy developed by the London-based NIESR (Barrell and Holland, 2002). A series of CEE economic data bases are assembled for the post Communist era, a generalised model is posited that is appropriate to each of the constituent economies, and cross-economy constraints are imposed. For example, a common marginal propensity to consume might be imposed on all models. This has the advantage of increasing the degrees of freedom and obtaining more precise parameter estimates. A possible disadvantage is that the cross-economy restrictions are difficult to test.

**(iii) Simple curve-fitting to post 1995 data**

This is the approach used in the Czech Republic HERMIN model and in a range of other CEE HERMIN models. Each CEE economy is studied in isolation. The limitation of at most about ten annual observations excludes econometrics, in the sense of hypothesis testing. By keeping the behavioural equations very simple, and restricting the use of lags, the number of behavioural parameters is kept to a minimum. Using ordinary least squares, a form of "curve-fitting" is used, where the derived parameters are examined and related to a range of estimates from other EU models, where longer data sets are available. In its extreme form, this reduces to the way in which computable general equilibrium (CGE) models are calibrated, by imposing all important parameters, and using one year's data to force congruence. Advantages include the tight theoretical control imposed on the model, the use of the most recent and consequently, most relevant data sample, and the use of judgement to ensure the relevance of the parameters. Disadvantages are numerous, including a complete lack of formal hypothesis testing.

The curve-fitting approach to calibrating the Czech Republic HERMIN model relies on judgement, aided by single equation estimation using "ordinary least squares" (OLS). We look to the OLS output to give us some usable curve-fitting information on the values of



model parameters that appear to make the behavioural equation roughly congruent with the data. However, we sometimes modify these calibrated parameters in the light of the underlying theoretical implications for the range of values as well as the empirical experience from others modelling exercises in the EU cohesion countries (such as Greece, Ireland and Portugal). Sometimes we impose a particular parameter value for which we have some prior (extra-model) knowledge in order to be able to estimate the remainder of the parameters. On almost all occasions we have therefore run several regressions with modified structure, from which we picked up the one fitting best the underlying assumptions (see Annex 5.2 for examples of this “data mining”, which is unavoidable when there is such a restricted data sample). In a few equations, we are simply unable to calibrate the parameters using OLS, and in those cases we impose values that are plausible in the light of the known characteristics of the Czech Republic economy. This is not a very satisfactory situation, but is somewhat better than the technique used in computable general equilibrium (CGE) models of calibration using a single observation.<sup>29</sup>

The Czech HCZ5 HERMIN model contains over 350 equations, many of which are included to increase the model's transparency and facilitate simulation and policy analysis exercises.<sup>30</sup> The essential core of the model consists of a smaller number of equations, of which about 29 are behavioural in a strictly economic sense (i.e., empirical versions derived from an underlying theoretical specifications, containing parameters that must be assigned data-dependent numerical values).

- GDP arising in manufacturing (OT)
- The factor demand system in manufacturing (employment (LT) and investment (IT))
- The GDP deflator for manufacturing (POT)
- Average annual earnings in manufacturing (WT)
  
- GDP arising in building and construction (OBC)
- The factor demand system in building and construction (employment (LBC) and investment (IBC))
- The GDP deflator for building and construction (POBC)
- Average annual earnings in building and construction (WBC)
  
- GDP arising in marketed services (OMS)

---

<sup>29</sup> It should be stressed that moving to the use of quarterly data will not remove the restriction on hypothesis testing by enlarging the sample (up to a factor of four). The intra-year cyclical movements of the data (such as seasonality) are of limited interest in a medium-term model like HERMIN.

<sup>30</sup> For example, the wage in manufacturing (WT) is determined in a behavioural equation. But the inflation rate (WTDOT) is determined in an identity, merely to facilitate the examination of simulation output.

- The factor demand system in marketed services (employment (LMS) and investment (IMS))
- The GDP deflator for market services (POMS)
- Average annual earnings in market services (WMS)
  
- GDP arising in agriculture, forestry and fishing (OA)
- Labour input in agriculture, forestry and fishing (LA)
- Fixed capital stock in agriculture, forestry and fishing (KA)
- Average annual earnings in agriculture (WA)
  
- The labour force participation rate (LFPR)
  
- Household consumption (CONS)
  
- Expenditure prices: investment (PIT, PIBC, PIMS, PIA, FIG, PIH), consumption (PCONS) and inventory changes (PDS)

The above set of behavioural equations is embedded amongst a larger set of identities, which are of vital importance to the performance and properties of the model, but do not contain numerical parameters that need to be calibrated. Together, the behavioural equations and the identities form an integrated system, and cannot be considered in isolation from each other.

With restricted time series, econometric estimation is only feasible if the number of parameters in each behavioural equation is kept to an absolute minimum. Hence, all HERMIN behavioural equations are kept as simple as possible, often at the price of poor within-sample tracking. We do not use any dummy variables. Structures such as the CES production function are imposed to make calibration easier. There is an obvious loss in modelling sophistication and in capturing dynamics of adjustment and behaviour, but there is little or nothing that one can do about these problems. The following sections provide discussion of the calibration process for each behavioural equation and technical details on the chosen specification.

## 5.2 THE SUPPLY SIDE OF HERMIN – MANUFACTURING

### (i) Manufacturing output

Among the behavioural equations for the manufacturing sector (T), a key role is played by the equation determining output. Based on the analysis contained in the previous section, we posit an equation of the form:

$$\log(OT) = a_1 + a_2 \log(OW) + a_3 \log(ULCT / POT) + a_4 \log(FDOT) + a_5 \log(POT / PWORLD) + a_6 t$$

Two main scale variables are the measure of the world output (OW) and final domestic absorption (FDOT). The variable OW is derived as a weighted average of the industrial production indices of the main trading partners of The Czech Republic, where the weights are constructed from export shares.

The variable FDOT, on the other hand, is constructed from input-output (I/O) weights and the main components of domestic absorption.<sup>31</sup> The real unit labour cost

$$RULCT = ULCT/POT$$

reflects short-term marginal cost effects, and the relative price term

$$PCOMPT = POT/PWORLD$$

computed as the manufacturing output price index over a measure of the world price index expressed in units of domestic currency, represents the price competitiveness of the tradable sector. The time trend is incorporated only to pick up any trend not captured by the other variables.

This is probably the most important equation in the model, yet we failed completely to calibrate the general form of the equation using simple OLS techniques. We examined the use of the export share data (i.e., the share of exports in GDP) to impose the coefficient on OW (the world “driver”), and calibrated the coefficient of FDOT (the domestic “driver”) as one

---

<sup>31</sup> The weights in the construction of FDOT capture the manufacturing output content of domestic absorption: consumption (CONS), government non-wage consumption (RGENW), and investment expenditure, decomposed into building and construction (IBCTOT) and machinery and equipment (IMETOT). The decomposition of total investment into IBCTOT and IMETOT components is needed to analyse the impacts of an NSRF-related shock to public investment, where this is likely to be mainly construction activity.

minus the coefficient of OW. The calibration search exercises also suggested negative values of the relative price (PCOMPT) elasticity and the real unit labour cost (RULCT) elasticity, as theory would suggest. But it is well known that these types of aggregated equations often have very low price elasticities, and larger elasticities only emerge when manufacturing is disaggregated into its component sub-sectors (Carlin, Glynn and Van Reenen, 2001).

After much experimentation, we had to impose most of the co-efficients, with the calibrated values of the behavioural parameters were specified as follows:

(OW) $a_2$	(RULCT) $a_3$	(FDOT) $a_4$	(PCOMPT) $a_5$	(t) $a_6$
0.5	-0.3	0.5	-0.3	0.0194

#### Parameters in manufacturing output equation (OT)

Hence, a 1 percent rise in Czech Republic real unit labour costs (RULCT) or in Czech price competitiveness (PCOMPT) will produce a 0.3 per cent decline in OT. A 1 per cent rise in world output (OW) will produce a 0.5 per cent rise in OT, while a 1 per cent rise in weighted domestic demand (FDOT) will also produce a 0.5 per cent rise. Even with a relatively crude parameter calibration, the within sample tracking performance of the equation is quite good.

#### (ii) Factor demands in manufacturing

We described in Section 4 how the CES production function was a useful form to use in modelling, being less restrictive than the Cobb-Douglas and yet remains relatively easy to handle:<sup>32</sup>

$$OT = A \exp(\lambda t) \left[ \delta \{LT\}^{-\rho} + (1 - \delta) \{KT\}^{-\rho} \right]^{-\frac{1}{\rho}},$$

where OT denotes output, LT labour and IT capital stock in the tradable sector. The parameter  $\lambda$  represents an exogenously given rate of technological progress, assumed for simplicity of calibration to be Hicks-neutral. Cost minimisation then yields the factor proportions equation:

$$\log(IT / LT) = \log\left(\frac{1 - \delta}{\delta}\right)^\sigma + \sigma \log(ERFPT),$$

<sup>32</sup> It must be kept in mind that the data constraints prevent us from using more sophisticated production functions, such as generalised Leontief, that might be more appropriate if we were to focus on the short-run transitional dynamics.

where  $\sigma$  represents the elasticity of substitution and ERFPT is a two year moving average of the relative price of labour over price of capital ratio.

Different choices can be made about the type of technical progress. In the “old” EU cohesion country models (Greece, Ireland, Portugal and Spain), where longer time series of data are available, both labour and capital embodied rates were investigated. However, this requires the calibration of two parameters and is impossible with the small sample of data available in the Czech Republic. Our choice of Hicks neutral technical progress was influenced by the structural change being experienced in the Czech Republic, where both the labour force and the capital stock are the channels of change. However, when we eventually come to analyse the impacts of the training schemes on factor productivity, we can incorporate these changes in the form of labour embodied technical change out-of-sample. Consequently, the original assumption of Hicks neutrality can be over-ridden or augmented by other kinds of technical change.

The first step of the calibration (Berndt, 1991) required estimation of the factor proportions (LT/IT) equation and yields two of the four production function parameters. Since unconstrained estimation yielded implausible results, we imposed a value between Cobb-Douglas and Leontief production functions by setting the elasticity of substitution to 0.50. The results of the second stage of the calibration procedure for Czech Republic manufacturing are summarised in the following table:

Parameter	A	$\sigma$	$\delta$	$\lambda$
Value	30.73	0.5 (imposed)	0.156	0.0473

CES production function parameters: manufacturing

Among the parameters, the technological rate of change has the largest impact on the dynamic behaviour of the model, because it imposes an exogenous steady state growth of this sector. Once its counterpart from the building and construction (BC) and market services (MS) sector demand equations is recovered (see below), the two will interact in shaping the growth of the economy. At about 4.7 per cent, the rate of technical progress in Czech Republic manufacturing appears somewhat low for a transition economy, but is higher than the rate in the “old” EU member states.

The within-sample fits are not very good, but capture the general trend. It must be remembered that the factor demand system has been theoretically imposed and has none of the ad-hoc additions and adjustments usual in such equations in empirical models.

**(iii) Manufacturing output price**

We attempt to model the pricing behaviour of the manufacturing sector as a mixture of both price taking and price setting behaviour. For the latter one can assume a mark-up on the unit labour cost which is also consistent with constant labour shares of added value according to the neoclassical theory of firm. What is more important, though, is that this sectoral price behaviour be constrained in relation to the nontradables by direct international competition. Therefore, a full pass through of labour cost increases into prices in a way that does not lead to any loss of competitiveness is only possible if foreign producers face the same shock. The following linearly homogenous equation is specified and calibrated:

$$\log(POT) = a_1 + a_2 \log(PWORLD) + (1 - a_2) \log(ULCT),$$

where PWORLD stands for a weighted measure of price indices external to the Czech Republic. At present, this is taken as a export-weighted average of the prices in the Czech Republic's main trading partners. Calibration of the above relationship yielded implausible results, so we imposed a coefficient of 0.70 on PWORLD (and consequently, 0.30 on ULCT). The coefficient on PWORLD is designed to capture the degree of openness of the Czech Republic manufacturing sector (i.e., the ratio of manufactured exports to gross output).

**(iv) Average annual earnings in manufacturing**

As described in the preceding section, and in keeping with the Scandinavian model of Lindbeck, 1979, wage rates in the manufacturing (or mainly tradable) sector are assumed to play a leading role in determining wage inflation in the whole economy. Hence, this equation is very significant for the behaviour of the model. In line with standard theory (Layard, Nickell, Jackman, 1991) and similar empirical studies (Bradley and Whelan, 1995), one usually assumes that wages in this sector are a product of bargaining between employers and labour unions.

The conventional theory of bargaining suggests four dominant factors of wage determination. The first is the price index of the sector output, POT. This, according to the neo-classical theory of firm, determines the maximum level of nominal wage that the employers are willing to pay for the existing level of employment to be profitable. The second is the sectoral labour productivity, LPRT, which increases the room for nominal wage rises consistent with preserving constant factor shares. Next, the tax wedge, WEDGE, comprising the effects of direct and indirect taxation including the social contributions, has an important role, because workers are concerned not with gross wages but with the net purchasing power of their wages. Finally, high unemployment reduces the bargaining power of labour unions, thereby alleviating their pressure for nominal wage rises. An obvious generalisation of the above discussion leads to the equation of the form:

$$\log(WT) = a_1 + a_2 \log(POT) + a_3 \log(WEDGE) + a_4 \log(LPRT) + a_5 \text{URBAR}$$

where WT denotes the level of average annual wage payments in the tradable sector, defined as the total sector wage bill over the sector employment, LPRT is the sector labour productivity computed as the sector output over the employment, WEDGE combines the direct and indirect implicit tax rates, and URBAR is a two-year moving average of the unemployment rate.

Having experimented with this equation, and examined the stylised facts of wage determination in the Czech Republic, we replaced it with a modified form as follows:

$$\text{Log}(WT/POT) = a_1 + a_2 \log(LPRT) + a_3 \text{URBAR}$$

where wages are now linked directly to output prices (POT), to a measure of productivity in manufacturing (LPRT), and to the unemployment rate. We imposed full price indexation. The calibration suggested a very high pass-through of productivity to wages, so we imposed a coefficient of 0.8. But we were unable to recover plausible coefficients on the tax wedge or on unemployment. We dropped the tax wedge term (since it only has a transitory effect at most), and imposed a value of  $-0.02$  on the Philips curve term (drawing on the Irish results as a comparison). The calibration yielded the following results, as a subset of the more general equation:

$a_2$	$a_3$
0.8 (imposed)	-0.02 (imposed)

Parameters in manufacturing wage equation (WT)

Hence, in this equation wages are assumed to be fully indexed to output prices (POT). Since 80 per cent of productivity growth in manufacturing is assumed to be passed on to wage earners, the result is that the share of added-value going to labour (i.e.,  $LSHRT=YWT/OTV$ ) is likely to be decline slowly over time. The inability to detect a negative Philips curve term is disturbing, since it excludes an important feedback mechanism from the model. However, we are not aware of any studies of the Czech Republic labour market that have identified this effect. We imposed a plausible parameter. The tracking performance is reasonably good and the general pattern of wage inflation is captured.

### 5.3 THE SUPPLY SIDE OF HERMIN – BUILDING AND CONSTRUCTION

#### *(i) Building and construction output*

Unlike in the manufacturing sector, which produces mainly tradable goods, the building and construction sector is normally assumed to be oriented towards supplying mainly domestic final demand. Thus, we specify an output equation of the form:

$$\text{Log}(OBC) = a_1 + a_2 \log(IBCTOT) + a_3 \log(ULCBC/PCONS) + a_4 t$$

where OBC denotes GDP arising in the building and construction sector, IBCTOT is total investment by all other sectors in building and construction activities, and (ULCBC/PCONS) is a measure of real unit labour costs. The calibration results are provided in the following table:

Parameter	$a_2$	$a_3$	$a_4$
Value	1.0 (imposed)	-1.07	-0.109

Parameters in building & construction output equation (OBC)

This means that a rise of one percent in IBCTOT is associated with a rise of one percent in BC-sector GDP. Output in the BC sector appears to be very sensitive to real unit labour costs, and a rise of one percent in these costs is associated with a decline of over 1 percent in output. The negative trend term (at over 10 per cent annually) is puzzling, and suggests that either the sector is suffering serious contraction, or else that the building and construction data are not very reliable. This issue will be examined at a later stage of the project, when the Czech NSRF impacts are being evaluated.

### **(ii) Factor demands in building and construction**

The calibration of the factor demands equation in the market services sector follows the same logic as in the manufacturing sector above. We assumed a CES production function of the type:

$$OBC = A \exp(\lambda t) \left[ \delta \{LBC\}^{-\rho} + (1 - \delta) \{IBC\}^{-\rho} \right]^{\frac{1}{\rho}},$$

where OBC, LBC, and IBC refer the familiar categories of output, labour and investment, this time in the building and construction sector. Similarly, the parameter  $\lambda$  denotes an exogenously given rate of technological progress, assumed to be Hicks-neutral.

Cost minimising behaviour implies the following equation that could be estimated:

$$\log(IBC / LBC) = \log\left(\frac{1 - \delta}{\delta}\right) + \sigma \log(ERFPBC),$$



where ERFBC represents the cost of labour relative to the cost of capital. As in the case of manufacturing, the unconstrained estimation gave implausible results in that the elasticity of substitution was greater than unity. Here we set the coefficient  $\sigma$  to 0.5, mid way between the Leontief and Cobb-Douglas cases. The parameters are summarised in the following table:

Parameter	A	$\sigma$	$\delta$	$\lambda$
Value	125.2	0.5 (imposed)	0.455	-0.031

CES production function parameters: building and construction

The implied rate of technical progress - at -3 per cent per year - is not uncommon in a sector that is still relatively traditional, unskilled, and labour intensive. However, together with the anomalous behaviour of trend in output (see above), this will be re-examined at a later stage.

We show below the (single equation) tracking of the actual factor demands versus the values predicted by the calibrated equations. The tables were produced by taking the factor demand equations (for LBC and IBC) and inserting the calibrated parameters. The fits are not good, but it must be remembered that the factor demand system has been theoretically imposed and has none of the ad-hoc additions and adjustments usual in such equations in empirical models.

### **(iii) Building and construction output price**

Recalling the discussion of the similar equation from the manufacturing (or mainly tradable) sector, we see that in this sector, which is fairly sheltered from international competition, there is no reason to assume that there would be any other factors apart from domestic cost conditions influencing the price behaviour. We therefore estimated the equation

$$\log(POBC) = a_1 + a_2 \log(ULCBC) + (1 - a_2) \log(ULCBC_{-1})$$

where POBC refers to the price index of the building and construction sector and ULCBC is the sector unit labour cost. The calibration yielded the value of the  $a_2$  coefficient of about 0.31. Hence, 31 per cent of changes in unit labour costs are reflected in prices within the same year, and the remaining 69 per cent with a lag of one year.

### **(iv) Average annual earnings in building and construction**

The bargaining-type equation determining the wage rate (more accurately, the average annual earnings) in manufacturing (WT) has been discussed above. The inflation rate of the manufacturing wage is assumed to be passed on to the building and construction sector (as well as to the market services, agriculture and public sectors), in an equation of form:

$$WBCDOT = WTDOT + \text{error}$$

$$WMSDOT = WTDOT + \text{error}$$

$$WADOT = WTDOT + \text{error}$$

$$WGDOT = WTDOT + \text{error}$$

where WTDOT, WBCDOT, WMSDOT, WADOT and WGDOT are the inflation rates of WT, WN, WA and WG respectively. The assumption made is relatively accurate in the case of all the non-traded sectors, but less accurate, but still broadly valid, in the case of the public sector (WGDOT), and agriculture (WADOT).<sup>33</sup> However, we retain the assumption in all sectors pending more detailed investigation of wage determination in the Czech Republic labour market.

## 5.4 THE SUPPLY SIDE OF HERMIN – MARKET SERVICES

### (i) Market services output

Unlike in the manufacturing sector, which produces mainly tradable goods, the market services sector is normally assumed to be oriented towards supplying mainly domestic final demand. Thus, we specify an equation of the form:

$$\text{Log}(\text{OMS}) = a_1 + a_2 \log(\text{FDOMS}) + a_3 \log(\text{ULCMS/PCONS}) + a_4 t$$

where OMS denotes GDP arising in the market services sector, FDOMS is a weighted measure of domestic demand (using I-O weights), and (ULCMS/PCONS) is a measure of real unit labour costs. The calibration results are provided in the following table:

Parameter	$a_2$	$a_3$	$a_4$
Value	0.49	-0.45	1.2

Parameters in market services output equation (OMS)

<sup>33</sup> Clearly, the path of WGDOT shown in the table is very “lumpy”, as periodic adjustments are made to the wage rates in non-marketed services in order to bring them into line with wage rises in the private (market) sectors. However, we are more interested in the medium-term trends in WGDOT rather than the year-on-year changes. The Scandinavian model assumptions provide a useful stylised out-of-sample projection mechanism.

This means that a rise of one percent in FDOMS is associated with a rise of half a per cent in MS-sector GDP. Output in the MS sector appears to be fairly sensitive to real unit labour costs, and a rise of one percent in these costs is associated with a decline of 0.5 percent in output. Trend output grows at the rate of 1.2 per cent per year.

### (ii) Factor demands in market services

The calibration of the factor demands equation in the market services sector follows the same logic as in the manufacturing sector above. We assumed a CES production function of the type:

$$OMS = A \exp(\lambda t) \left[ \delta \{LMS\}^{-\rho} + (1 - \delta) \{IMS\}^{-\rho} \right]^{\frac{1}{\rho}},$$

where OMS, LMS, and IMS refer the familiar categories of output, labour and investment, this time in the market services sector. Similarly, the parameter  $\lambda$  denotes an exogenously given rate of technological progress, assumed to be Hicks-neutral.

Cost minimising behaviour implies the following equation that could be estimated:

$$\log(IMS / LMS) = \log\left(\frac{1-\delta}{\delta}\right)^{\sigma} + \sigma \log(ERFPMS),$$

where ERFPMS represents the cost of labour relative to the cost of capital. As in the case of manufacturing, the unconstrained estimation gave implausible results in that the elasticity of substitution was greater than unity. Here we set the coefficient  $\sigma$  to 0.5, mid way between the Leontief and Cobb-Douglas cases. The parameters are summarised in the following table:

Parameter	A	$\sigma$	$\delta$	$\lambda$
Value	20.86	0.5 (imposed)	0.0655	0.023

CES production function parameters: market services

The implied rate of technical progress, at 2.3 per cent per year, is considerably lower than in the more capital intensive manufacturing sector, where it was 4.7 per cent.

In the tables below we show the (single equation) tracking of the actual factor demands versus the values predicted by the calibrated equations. The tables were produced by taking the factor demand equations (for LMS and IMS) and inserting the calibrated parameters. The fits are not good, but it must be remembered that the factor demand system has been

theoretically imposed and has none of the ad-hoc additions and adjustments usual in such equations in empirical models.

**(iii) Market services output price**

Recalling the discussion of the similar equation from the manufacturing (or mainly tradable) sector, we see that in this sector, which is fairly sheltered from international competition, there is no reason to assume that there would be any other factors apart from domestic cost conditions influencing the price behaviour. We therefore estimated the equation

$$\log(POMS) = a_1 + a_2 \log(ULCMS) + (1 - a_2) \log(ULCMS_{-1})$$

where POMS refers to the price index of the market services sector and ULCMS is the sector unit labour cost. The calibration yielded the value of the  $a_2$  coefficient of about 0.73. Hence, 73 per cent of changes in unit labour costs are reflected in prices within the same year, and the remaining 27 per cent with a lag of one year.

**(iv) Average annual earnings in market services**

The bargaining-type equation determining the wage rate (more accurately, the average annual earnings) in manufacturing (WT) has been discussed above. The inflation rate of the manufacturing wage is assumed to be passed on to the market services sector (as well as to the agriculture and public sectors), in an equation of form:

$$WMSDOT = WTDOT + \text{error}$$

## 5.5 THE AGRICULTURE SECTOR

We make no attempt to model this sector behaviourally in a sophisticated way. In order to separate the agriculture from other sectors of the economy, we simply model its key variables as time trends, as shown in the following equations. Here, OA stands for the output in agriculture, LA refers to the sector employment and KA denotes the sectoral capital stock.

**(i) Agricultural output:**

This is modelled as a labour productivity relationship, as follows:

$$\log(OA/LA) = 4.87 + 0.084 t$$

Hence, productivity in agriculture has grown at a trend rate of 8.4 per cent per year over the period 1995-2004.

**(ii) Employment in agriculture:**

Rather like the cases of Ireland and Portugal, employment in the Czech Republic agriculture sector is in trend decline. This is captured by the following simple equation:

$$\log(LA) = 6.06 - 0.060 t$$

Hence, employment in agriculture has declined at a trend rate of 6 per cent per year over the period 1995-2004.

**(iii) Fixed capital stock in agriculture:**

Unlike the preceding two sectors, where we modelled the investment demands behaviourally and accumulated the capital stock over time, here we assume that the capital-to-output ratio (KA/OA) follows a time trend. The calibrated equation yielded:

$$\log(KA/OA) = 1.66 - 0.014 t$$

Hence, the capital intensity of agricultural output appears to have *decreased* at a rate of 1.4 per cent per year over the period 1995-2004.

## 5.6 THE NON-MARKET SERVICES SECTOR

This is another sector whose behaviour is treated as mainly exogenous. There are only two behavioural equations, namely wage and price equations, of which only the former is behavioural in any strict economic sense.

**(i) Average annual earnings in the non-market services sector**

This equation merely adopts the assumption of the Scandinavian model discussed above, and model wage inflation as being driven by wage inflation in manufacturing (see above).

**(ii) Output price in non-market services**

This is only a quasi-behavioural equation, since we assume the deflator of public sector output follows the public sector wage inflation. We rely on the fact that output in this sector is primarily composed of wages to state employees. Hence.

$$POG/POG_{-1}=WG/WG_{-1},$$

with POG denoting the public sector output deflator and WG is the wage rate.

**5.7 DEMOGRAPHICS AND SUPPLY OF LABOUR**

Population in the following three age groups is assumed to be exogenous in the present version of the Czech Republic HERMIN model: NJUV (aged up to 14), NWORK (working age, 15-64), and NELD (the elderly population, aged over 65). In this area of the model, the only semi-behavioural equation is the labour force participation rate (LFPR), i.e., the percentage of the working age population (NWORK) that is in the active labour force (LF).

**(i) Labour force participation rate**

The recorded rate of labour force participation (LFPR) has declined steadily during the 1990s. At present we simply capture this pattern of behaviour as a time trend.

$$LFPR = 78.37 - 0.43 t$$

**5.8 THE ABSORPTION SIDE OF HERMIN****(i) Private Consumption:**

We have adopted a rather simple approach and assume that consumption depends solely on the real disposable income of households, thus invoking a liquidity constraint and ignoring intertemporal optimisation of households. This feature gives the absorption side a strong Keynesian flavour. At this stage of the modelling exercise we decided to neglect any possible financial wealth or real interest rate effects. However, because we believe these effects to be of great significance for the period of transition characterised by negative or zero real interest rates and windfalls of additional income through mass privatisation, we propose to return to this issue in the future developments of the Czech Republic model.

In the simple case of liquidity constrained consumers, consumption expenditure (CONS) is a function of real personal disposable income (YRPERD). In the simplest possible functional form, the following linear relationship is applied:

$$\text{CONS} = a_1 + a_2 \text{YRPERD}$$

where the crucial parameter is the marginal propensity to consume (MPC), measured by the size of the parameter  $a_2$ . The calibration suggested an MPC of 0.79. This is in the expected range.

We must, of course, recognise that the data from the second half of the 1990s are probably still characteristic of an incomplete transition, and the later observations are more likely to have been generated by underlying structures from the second (or “cohesion-like”) phase of transition. It is the structure of the economy in this second phase that is of interest. This problem of structural change obviously exacerbates an already bad data situation and tends to throw more emphasis on the need to over-ride the OLS parameters and insert crucial parameter values taken from EU cohesion country estimation (e.g., Greece, Ireland, Portugal).

## 5.9 EXPENDITURE PRICES

In HERMIN we model several different expenditure price equations. The behavioural assumption underlying all of them is that they should reflect the price indices of the purchased portfolio of products, i.e. on our level of disaggregation, the GDP deflator and the deflator of imports. Therefore, they all are captured by the following specification:

$$\text{Log}(P^*) = a_1 + a_2 \text{log}(PGDPFC) + (1 - a_2) \text{log}(PM),$$

where  $P^*$  stands for the various expenditure price indices, PGDPFC is the deflator of GDP at factor cost and PM is the price of imports. The only exception to this simple formulation is the consumption deflator, which must also reflect, apart from price effects, the effect of indirect taxation (TINC), requiring an additional term.

There are eight such equations in the Czech Republic model. They explain the investment deflators, the consumption deflator and the deflator of inventory changes. The calibration results were as follows:

	<b>PGDPFC</b>	<b>PM</b>	<b>TINC</b>
Equation for PIT	0.335	(1-0.424)	0.0
Equation for PIBC	0.966	(1-0.966)	0.0
Equation for PIMS	0.663	(1-0.663)	0.0
Equation for PIA	0.396	(1-0.396)	0.0
Equation for PIG	0.695	(1-0.695)	0.0
Equation for PIH	0.9 (imposed)	(1-0.9)	0.0
Equation for PCONS	0.916	(1-0.916)	1.0 (imposed)
Equation for PDS	0.8 (imposed)	(1-0.8)	0.0

#### Parameters for expenditure price equations

What this implies is that the investment expenditure deflators are partially anchored to movements in import prices (PM) and partially reflect movements in domestic output prices (PGDPFC). The deflator for investment in manufacturing and agriculture are most anchored to import prices, since they probably contain a high element of imported machinery and equipment. The deflator of investment by the building and construction sector is the least anchored to import prices, and appears to be determined mainly by the domestic price.

### 5.10 GOVERNMENT EXPENDITURE

We now come to the discussion of the modelling of public sector expenditure, taxation, borrowing and debt accumulation. We will concentrate only on the key equations which, although not behavioural in a strict economic sense, embody our views on how the public sector works. Even though we are aware that it is only a simplification of the complex processes shaping this sector, we believe we have picked up the most relevant mechanisms.

Many of the expenditure items are treated as exogenous. However, for the most important ones we used an exogenous expenditure rate which applies to a certain base defined in the model.

#### *(i) Domestic transfer payments (GTRSW)*

These are mainly social welfare payments and pensions, and are indexed to prices. Thus

$$GTRSW = RGTRSW * (N*PCONS)$$



where  $N$  is the total population and  $PCONS$  is the deflator of private consumption expenditures.

### **(ii) Unemployment transfers (GTRU)**

We assume the unemployment transfers are paid to all the unemployed ( $U$ ), at a rate of  $RGTRU$  per person per year. Those actually eligible for payments are a subset of total unemployed. If the ratio of eligible to total stays approximately constant, then this approach produces a correct forecast of total transfer payments ( $GTRU$ ). Finally, the (nominal) rate of transfer ( $RGTRU$ ) is indexed to average annual earnings in the non-agriculture sector ( $WNA$ ).

$$GTRU = RGTRU * U$$

$$RGTRU/RGTRU(-1) = WNA/WNA(-1)$$

### **Subsidies (GSUBPD and GSUBO)**

Subsidy payments ( $GSUBPD$  and  $GSUBO$ ) are linked to a GDP base, as follows:

$$GSUBPD = RGSUBPD * GDPFCV$$

$$GSUBO = RGSUBO * GDPFCV$$

This has the effect of causing subsidy payments to increase in line with nominal GDP. If it is desired to break this link (say, to run down subsidies as a share of GDP), then they can simply be treated as exogenous instruments. Most other less important items of public expenditure are treated as policy instruments. With respect to expenditure on public sector wages, the policy instrument is numbers employed ( $LG$ ), and the wage rate is linked to the rate in manufacturing. Hence, the public sector wage bill is endogenous.

## **5.11 TAXATION AND REVENUE**

A large part of the taxation revenue is driven by exogenously given taxation rates (such as the average indirect tax rate), which are levied on appropriate taxable bases.

### **(i) Personal income taxation**

These taxes are assumed to be levied on total wage income ( $YW$ ). Hence,

$$GTYP = RGTYP * YW$$

**(ii) Revenue from corporate taxation (GTYC)**

These taxes are assumed to be levied on corporate profits, lagged one year (YC(-1)):

$$GTYC = RGTYC * YC(-1)$$

**(iii) Indirect taxation**

Here the tax base is assumed to be consumption (CONSV), and the tax rate is RGTEPD. Hence, total revenue (GTEPD) is

$$GTEPD = RGTEPD * CONSV$$

**(iv) Import duties (GTM)**

These taxes are assumed to be levied on the value of total imports (MV) at a rate RGTM:<sup>34</sup>

$$GTM = RGTM * MV$$

**(v) Other (non-tax) revenues (GREVO)**

Revenue from this residual category (GREVO) is linked to a GDP base at an implicit rate RGREVO:

$$GREVO = RGREVO * GDPFCV$$

## 5.12 THE PUBLIC SECTOR BORROWING REQUIREMENT (GBOR)

The public sector deficit (GBOR), is determined as the difference between government expenditure and revenues, i.e.

$$GBOR = (GEXP - GREV)$$

---

<sup>34</sup> Note that HERMIN models the net trade surplus (NTSV) and does not contain separate trade equations (for imports and exports). To model import duties, the value of GDP is included as a proxy for the missing data on MV.

where GEXP is total (current and capital) expenditure and GREV is total revenue, including any revenue from abroad (such as development aid or pre-accession Structural Funds).

The public sector borrowing requirement (GBOR) is assumed to accumulate into a stock of public debt (GND):

$$GND = GND(-1) + GBOR$$

The government debt service, in terms of a flow of interest payments (GTRND), is computed using an interest rate (RGND), applied to the debt:

$$GTRND = (RGND/100) * GND(-1)$$

## 5.13 NATIONAL INCOME

### *(i) Undistributed corporate profits*

Ideally we would like to link the retained corporate profits (YCU), to the total level of profits (YC), which is the obvious base, in an equation of form:

$$YCU = YCURAT * YC$$

Since only the distributed element of corporate profits (YC-YCU) should properly enter into personal income, this mechanism is important within the model. However, since we were unable to obtain data for the Czech Republic, we imposed a coefficient of 0.20 for the implicit rate YCURAT, so that we assume that 80 per cent of corporate profits enter into personal income, 20 per cent being retained within the corporate sector for investment purposes.

---

## MODEL TESTING AND RESPONSES TO SHOCKS

### 6.1 INTRODUCTION

The behavioural equations and identities of the new Czech HERMIN model have been described in the first report in this project (Bradley, Pisa, Untiedt and Vavra, 2006: Report 1), and are not repeated here. In that report we described the first stage of model testing, namely the calibration of the model, and the simulations that were designed to check the with-sample tracking performance. It was stressed that HERMIN is not a model designed for short-term forecasting. It includes none of the special fixes and dummy variables that are commonly used to ensure good within-sample performance, but often at the expense of a sound theoretical structure. In this section we subject the model to further tests, and examine the performance of the system of equations as a whole.

Since one important equation has been altered since the first version of the model that was presented in Report 1, we re-checked the validation and internal consistency of the model by means of within sample simulations. Having described briefly describe the process of forcing the model's behavioural equations to track the within-sample data exactly (i.e., "fixing" of intercept adjustments or "add-factors" for the behavioural equations of the model), we then present a simple projection scenario that attempts to construct a medium term forecast, predicated on an assumed development of the exogenous (or driving) variables of the model. Finally, we subject the model again to the same series of exogenous and policy shocks described in Report 1 in order to explore its responses.

### 6.2 CHECKING THE MODEL STRUCTURE

Even though the model is primarily designed for policy oriented experiments and multiplier analyses, we do not neglect its within sample performance. Not only is a reasonable within sample tracking a necessary condition for the model to be realistic, but it would also point out the weak parts of the model, i.e. the behavioural equations whose calibration neglected some important factors. Therefore checking of the model's within sample properties provides valuable information on the quality of the calibration process and was used in the design stage of model construction, when we often had to return back to the calibration stage when such a check produced unsatisfactory results.

The control of the within sample performance was carried out by a means of a so-called residual check simulation. Once the individual behavioural equations were calibrated, and the model as a parameterised system of equations was set up, we ran a static simulation which used the historical values of the endogenous and exogenous variables on the right hand side of each equation of the model to compute the behavioural variable that is determined by this equation. The resulting set of values of the endogenous variables for every

simulated year of the sample was then compared to their actual historical values. More specifically, we were interested in the percentage difference of the simulated from actual values.

There is no obvious benchmark as to what percentage difference constitutes a reasonable fit of an equation. Rather it varies from a case to case, but overall we aimed at less than 10 per cent difference for all of the most important behavioural variables. Of course, variables computed as identities must, by definition, fit exactly if simulated in this “single-equation” way, up to a numerical rounding error. In addition, we also wanted these differences for each behavioural variable to change signs over time, suggesting a random error. Unless this residual check produced satisfactory results, we had to come back to calibration of the most troublesome equations and once more review the whole process. In the end, we finished with most behavioural variables showing less than 5 per cent difference from the historical values in every year. The main exceptions were investment variables, which are very difficult to track with a model of the constrained type that we are using. On balance, the within sample tracking results boosted our confidence in the ability of the model to reflect reality reasonably well. However, it falls far short of the rigorous testing normally carried out on econometric models, where long and stable time series of data are available and support rigorous econometric analysis.

Having performed the residual check procedure described above, we obviously wanted to use the information on the magnitude of error that the individual equations were making during the within sample check, in the out of the sample projections and simulations. In order to do so, we carried out a static within sample simulation as before, but this time we solved each equation independently and not as part of the simultaneous system. We then computed absolute difference between the simulated and true values. These absolute differences created the so called constant adjustment (or CA) factors for each behavioural variable and within sample year of simulation. These adjustment factors are, in fact, corrections to our estimates of behavioural intercepts in each behavioural equation, with the property that they make the computed variable exactly fit the data. Therefore, if we add these constant adjustment factors back to each behavioural equation we will obtain a perfect fit of the whole model, within sample. What is more important, though, is that we can use this information on the error in our behavioural intercepts in the out of the sample projections and simulations, as will be shown below.

### 6.3 A NOTE ON BASELINE SCENARIOS

The reason why we need a baseline scenario is that we require a “counterfactual” projection of the economy into the future against which we can evaluate the future impacts of any policy decisions. In the case of evaluating the impacts of the Structural Funds within the NSRF, we need a baseline scenario that extends very far into the future, since the SF policies are implemented for a horizon that stretches to 2013 (for NSRF 2007-2013), and to 2015, if one takes into account the so-called “n+2” rule.

But we actually need to go beyond the year 2015, since the main supply-side benefits of the SFs will only occur *after* the funding ceases. This is because the increased and improved stocks of physical infrastructure and human capital, as well as R&D, etc., will generate long-term benefits that endure *after* the SFs cease.

It is important for the reader to be aware of some distinctions between forecasts and projections.

**Definition 1: *Projection*:** A “baseline” projection is any simulation generated by the model when a set of projections of all the exogenous variables is fed into the model, and results are generated for all the endogenous variables

**Definition 2: *Forecast*:** A “baseline” projection (according to Definition 1 above) becomes a “forecast” when the assumptions for the exogenous variables are prepared in line with informed analysis by national and international experts, and where the initial model projections are adjusted in light of off-model information by these experts as well as by the model operators.

If we were only interested in the NSRF impacts, then any reasonable baseline projection could be used. Policy impacts are not sensitive to the exact nature of the baseline.<sup>35</sup> One could derive the baselines in a very simple way, and not pay very much attention to the “realism” of the assumptions or the fine detail of the projection. But there is usually a very particular interest in the baseline projection itself, as well as in the “levels” of the “with-NSRF” simulation. This means that every effort should be made to choose realistic values for the out-of-sample exogenous variables and policy instruments. In that way we can move to a more realistic medium/long-term forecast, and be in a position to stand over the quality and realism of the baseline.

#### **(a) Short-term forecasts (2005-2007)**

Note that the year 2005 has to be “backcast”, since we will only have national accounting data up to 2004. Realistically, it is only feasible to generate a credible economic forecast for a time horizon of from 1 to 2 years ahead, and even then they will be subject to unexpected factors (oil-price shock, recession in the USA, terrorist actions, weather, fiscal and/or monetary instability, etc.).

A wide range of Czech institutions and agencies produce these kind of short-term forecasts, with varying degrees of credibility. In few cases are these forecasts accompanied by any detailed background explanations. It also appears that in no cases are the short-term forecasts produced using the assistance of formal economic models.

#### **(b) Medium-term national forecasts (2005-2010)**

The real challenge comes when you try to move the forecast horizon out to (say) five years. This is probably the longest horizon over which “forecasts” can be prepared (as distinct from “projections”). The execution of a credible medium-term forecast (say, for the period 2006-

---

<sup>35</sup> More technically, for a linear model, the policy multipliers are invariant with respect to the nature of the baseline. A model like HERMIN is quasi-linear, and the policy multipliers are not sensitive to the baseline, within a wide range of outcomes.

2010) would be a major undertaking. This would ideally be carried out by GEFRA/EMDS in collaboration with another Czech economic agencies who specialise in forecasting.<sup>36</sup>

**(c) Long-term national projections (2006-2020)**

Note the change in terminology from “forecast” to “projection”. As mentioned above, we need to move at least ten years beyond the 2010 time horizon for the medium-term forecast. This is so far into the future that the resulting projections are merely illustrative of what is likely to happen if present structures and trends are continued into the future. We do not expect these projections to be realised in practice. But they serve to highlight some issues that will need to be addressed by the NSRF.

To be more accurate, the long-term “without-NSRF” baseline projection would ideally have three component parts. The period 2005-2007 would be forced to be consistent with the short-term forecast (based on a consensus of available Czech forecasts); the period 2008-2010 would be forced to be consistent with the medium-term forecast (once again, assuming that one had been prepared in detail); the period 2011-2020 would be more in the nature of a “projection”, as defined above.

## **6.4 PROJECTIONS: EXTERNAL AND POLICY ASSUMPTIONS**

Before we could proceed with the policy variable shocks and experiments (described below), as well as the NSRF impact analysis to be described later in this report, we need to set up a baseline scenario. This is an out of the sample simulation designed as an experimental scenario contingent on a particular future development of the exogenous (or driving) variables in the model. Although we try to set these variables according to a sensible judgement, we have done so in a fairly simple way. However, if the basic validity of the Czech Republic HERMIN (HCZ5) model is accepted, then the projections for the exogenous variables can always be refined and made more realistic in the light of specialist local and more up-to-date knowledge. The setting up of this future scenario is important. It enables us to further judge the ability of the model to reflect the major trends shaping the current development of the economy of the Czech Republic and to provide a baseline scenario for the shocks that we will describe later.

For the purposes of out-of-sample projection, the external and policy variables can be grouped into five different types, as follows:

---

<sup>36</sup> In the case of the Irish economy, every two years a formal, model-based, medium-term forecasting exercise is carried out by the ESRI, and published as its *Medium-term Review*. A time horizon of five years is used for the detailed forecast. Less detailed forecasts are prepared for a further five years.

### **External (or world) variables**

There are about 20 variables in this important category.

- (a) World economic growth: The rate of growth of manufacturing output in the Czech Republic's main trading partners (i.e., the main export destinations that include Germany, France, Italy, the United Kingdom, etc.) is assumed to be in the region of 3 per cent per year from 2005-2020.
- (b) External prices: These include the price of imports (PM), agricultural prices (POA), as well as the output prices of manufactured goods in a series of the Czech Republic's main trading partners.<sup>37</sup> A common inflation rate of 3 per cent per year is assumed for the period 2005-2020.
- (c) German unemployment rate: This is available for use should one wish to endogenise migration flows. But in the preliminary version of the Czech Republic model, migration flows are left exogenous.

### **Internal (or policy) variables**

These are mainly public expenditure instruments (including public sector employment) and tax rates, and there are over twenty variables in this category.

- (a) Public employment (LG): Employment numbers are frozen at their 2004 value.
- (b) Other elements of real public consumption (RGENW, OGNW): These are frozen at their 2004 values.
- (c) Other elements of public expenditure (e.g., IGV): These are projected to grow in nominal terms at the same rate as world prices (i.e., 3 per cent per year). Thus, they are assumed to be maintained approximately fixed in real terms, *ex ante*.
- (d) Tax rates: These are fixed at their 2004 values. Consequently, revenues (in nominal prices) will grow at the same rate as the relevant tax base (e.g., CONSV in the case of RGTE, the rate of indirect taxes).
- (e) The exchange rates of the Czech Republic currency against the currency of its main trading partners: These are projected as being fixed at their 2004 values. In the next revision of the HERMIN model, a monetary sector will be incorporated, and will allow for the possibility that exchange rates could vary.

---

<sup>37</sup> In HERMIN models of EU countries, the exogeneity of agricultural prices follows from the Common Agriculture Policy (or CAP). For the Czech Republic, the exogeneity assumption was made for lack of any plausible alternative mechanism.



### **Other exogenous variables**

There are two main categories: trade weights and a miscellaneous category.

- (a) Trade weights: These are used in the model to weight the components of world output growth. In the projection, it is assumed that they are fixed at their 2004 values (see above).
- (b) Miscellaneous: Most remaining exogenous variables are projected as being fixed in real terms, *ex ante*.

### **Modifications of time trends**

A range of time trends have been used in the model, and values were calibrated using the within-sample data from 1995-2004. However, it would be unwise to project these trend rates of growth unchanged into the medium term without some reflection on their characteristics. The following are the main assumptions made about the future path of the key time trends in the HERMIN HCZ5 model:

- (a) Hicks neutral technical progress: The calibrated values within-sample were 4.7 per cent, minus 3 per cent and 2.3 per cent for manufacturing, building and construction, and market services, respectively. Out of sample, the rate for manufacturing was left at its calibrated value; and the low rate for market services was projected to increase slightly in the future. But the very anomalous (negative) rate for building and construction was set to become positive out of sample.
- (b) Agricultural productivity growth: The within-sample growth rate of 8.3 per cent per year was projected unchanged.
- (c) Agricultural employment: The within-sample decline of 6 per cent per year was reduced by 50 per cent, and a trend rate of decline of 3 per cent per year was imposed.
- (d) The capital/output ratio in agriculture: The within sample growth rate of minus 1.4 per cent was projected at zero out of sample.
- (e) Labour force participation rate: The within-sample annual decline was about 0.4 of a percentage point per year. This was set to zero out of sample, and consequently the participation rate was frozen at its 2004 value.
- (f) Trend sectoral output growth: The rate in manufacturing (calibrated at 2 per cent per year), was halved out of sample; the rate in building and construction (calibrated at minus 10 per cent), was effectively reduced to zero out of sample. The rate for market services (calibrated at the low rate of 0.1 per cent per year) was left unchanged.

### ***Behavioural intercept adjustments***

For the calculation of these, see above. We make the simple assumption that the value of the 2004 within-sample error for the behavioural equations is projected forward to 2020 unchanged. However, where a behavioural equation defines a rate of change or a flow (e.g., wage inflation in the MS-sector (WMSDOT), etc.), then we project the error as zero.

## **6.5 A STYLISED PROJECTION FOR 2005-2020**

As noted above, it is not our intention in this paper to produce a finely tuned realistic forecast for the Czech Republic economy for the next ten to fifteen years! Even if such an exercise were useful, it would require very detailed analysis of the external economic environment, the domestic Czech Republic policy environment, and a more detailed modelling of issues such as the role of structural funds, the single European market, and foreign direct investment in promoting re-structuring of the Czech Republic economy. Our intention here is merely to illustrate the projection methodology by making the above simple stylised assumptions, and inserting them into the current version of the Czech Republic HERMIN model.

In Table 6.5.1 we show the projections for some of the main macroeconomic aggregates. In this table, GDP(g) is the growth rate of GDP. For the years 2000-2004 (inclusive), this is the actual national accounting data. For the years 2005-2020, the projections are generated by the model. After the slow-down of 2000-2003, growth resumes at a rate of over 4 per cent per year.

L(g) represents the growth rate of aggregate employment. Given the projected high rate of productivity growth (LPROD(g)), the rate of growth in employment is considerably smaller than the growth of output.

The modest growth in employment, combined with an (essentially) static labour force, results in a slow drift downwards in the rate of unemployment (expressed as a percentage of the labour force). Note that UR(l) is the level of unemployment.

Table 6.5.1:  
Performance of macro aggregates in baseline

Year	GDPM (g)	L (g)	UR (I)	LPROD (g)
2000	4.29	-0.48	8.62	5.49
2001	2.86	0.40	7.96	1.73
2002	1.27	1.53	7.08	0.12
2003	2.86	-1.35	7.61	3.96
2004	5.32	0.08	8.07	5.58
2005	4.58	1.27	7.37	3.19
2006	3.95	0.43	7.44	3.43
2007	4.28	0.76	7.20	3.42
2008	4.11	0.57	7.13	3.44
2009	4.21	0.67	6.97	3.44
2010	4.18	0.64	6.84	3.45
2015	4.26	0.71	5.94	3.47
2020	4.29	0.75	4.82	3.48

The next set of four tables conveys some detail of the baseline projection. Aggregate growth of GDP is above the rate of world growth (Table 6.5.2). Growth in agriculture is highest, then manufacturing and then market services. Building and construction, on the other hand, is seen to grow only modestly. It should be recalled that the calibrated negative trend of 10 per cent per year, and was reduced essentially to zero out of sample.

Employment growth is modest, at least until the end of the extended projection period (Table 6.5.3). This is made up of a continuing decline in agriculture, a modest decline in building/construction, frozen public sector employment, and significant rises in manufacturing and market services. The rate of unemployment stays fairly static, until the end-of-period growth starts to reduce it.

Table 6.5.2:  
Sectoral output growth rates (percent)

Date	OW	OT	OBC	OMS	OA	OG	GDPFC
2001	0.11	-3.32	-8.16	7.28	-6.98	2.20	2.14
2002	-0.54	10.76	3.14	-2.29	2.84	0.79	1.65
2003	0.56	7.45	5.05	0.10	4.82	0.61	2.55
2004	2.90	6.67	-0.46	7.27	2.12	-0.39	5.66
2005	3.00	5.94	6.36	4.19	6.41	0.00	4.50
2006	3.00	4.88	1.67	3.90	6.38	0.00	3.87
2007	3.00	5.25	2.57	4.21	6.36	0.00	4.20
2008	3.00	5.06	1.87	4.01	6.33	0.00	4.03
2009	3.00	5.14	2.16	4.10	6.31	0.00	4.14
2010	3.00	5.08	2.03	4.07	6.29	0.00	4.11
2015	3.00	5.00	2.24	4.12	6.23	0.00	4.21
2020	3.00	4.90	2.38	4.11	6.20	0.00	4.26

OW: "world" output; GDPFC: real GDP at factor cost; OT: GDP in manufacturing  
OBC: GDP in building & construction; OMS: GDP in market services; OA: GDP in agriculture; OG: GDP  
in non-marketed services

Table 6.5.3:  
**Employment and unemployment levels (thousands)**

Date	L	LT	LBC	LMS	LA	LG	LF	U	UR
2001	4837	1338	411	2056	208	824	5256	418	8.0
2002	4912	1382	386	2131	189	824	5286	374	7.1
2003	4845	1313	416	2073	205	838	5244	399	7.6
2004	4849	1294	415	2087	203	851	5275	426	8.1
2005	4910	1308	432	2123	197	851	5301	391	7.4
2006	4931	1307	429	2153	192	851	5327	396	7.4
2007	4969	1311	430	2191	187	851	5354	385	7.2
2008	4997	1313	427	2225	182	851	5381	384	7.1
2009	5031	1316	426	2261	177	851	5408	377	7.0
2010	5063	1318	425	2298	172	851	5435	372	6.8
2015	5241	1325	421	2493	151	851	5572	331	5.9
2020	5438	1327	420	2708	132	851	5713	275	4.8

L = total employment; LT = manufacturing; LBC = building & construction; LMS = market services; LA = agriculture; LG = non-market services; LF = total labour force; U = numbers unemployed; UR = unemployment rate

The consequences for the public sector borrowing requirement, the national debt, and the trade balance (all expressed at a percentage of GDP), are shown in Table 6.5.4. The level of borrowing stays fairly high, and the debt/GDP ratio drifts upward. However, the trade balance shifts into surplus towards the end of the projection period.

Finally, the inflation environment is very much a consequence of the assumed world inflation rate of 3 per cent per year, and the fixed exchange rate. The Czech Republic inherits this rate of inflation (Table 6.5.5), as a consequence of the above nominal “anchors”. However, the rate of inflation in market services is higher than in manufacturing, since it is the latter sector that is exposed to strong international price competition.

Table 6.5.4:  
Public and private sector imbalances

Date	GBORR	RDEBT	NTSVR
2001	5.95	17.47	-2.54
2002	4.79	18.41	-2.05
2003	9.40	21.64	-2.21
2004	8.13	23.82	-0.47
2005	8.10	26.12	0.20
2006	8.18	28.64	0.42
2007	8.10	31.15	0.76
2008	7.99	33.67	1.06
2009	7.83	36.07	1.39
2010	7.64	38.31	1.71
2015	6.12	45.65	3.48
2020	3.88	44.76	5.50

GBORR = public sector borrowing requirement (as % of GDP); GBORIMFR = PSBR, inclusive of privatisation receipts; RDEBT = national debt (as % of GDP); NTSVR = net trade surplus (as % of GDP)

Table 6.5.5:  
The inflation environment

Date	PWORLD	POT	POMS	PGDPFC	PCONS	WT	LPRT	ULCT	RULCT
2001	-1.64	5.87	4.08	5.59	3.46	4.96	-6.08	12.31	6.08
2002	-10.12	-3.18	5.67	2.99	0.74	4.32	7.24	-2.97	0.22
2003	2.86	-2.32	4.51	3.57	1.79	6.81	13.13	-6.54	-4.32
2004	2.13	2.78	-1.32	1.21	2.21	7.34	8.20	-0.92	-3.60
2005	3.00	2.69	3.43	3.76	3.77	6.92	4.86	1.96	-0.71
2006	3.00	2.86	4.86	4.35	4.33	7.58	4.94	2.52	-0.33
2007	3.00	2.65	4.51	4.02	4.01	6.86	4.91	1.85	-0.78
2008	3.00	2.71	4.48	3.99	3.99	7.07	4.92	2.05	-0.65
2009	3.00	2.68	4.45	3.94	3.94	6.94	4.91	1.93	-0.73
2010	3.00	2.71	4.48	3.96	3.95	7.04	4.92	2.02	-0.67
2015	3.00	2.75	4.65	4.03	4.00	7.19	4.92	2.16	-0.57
2020	3.00	2.79	4.78	4.09	4.05	7.32	4.92	2.29	-0.49

PWORLD = "world" manufacturing price; POT = manufacturing output price; POMS = Market services output price  
 PGDPFC = GDP price; PCONS = consumption price; WT = wage rate in manufacturing;  
 LPRT = productivity in manufacturing; ULCT = unit labour costs in manufacturing; RULCT = real unit labour costs

The above projections are rather tentative in nature and should be interpreted with care. When they are compared with the "official" medium-term forecasts, we may be able to learn something about the mechanisms of the model and perhaps we may also be able to learn something about the logical assumptions underlying the "official" forecasts.

## 6.6 SHOCKING THE MODEL

We now examine the properties of the Czech Republic HERMIN model using a series of simulated shocks to exogenous variables. In order to examine the full medium-run properties of the model, we need to simulate the model over a long period. To do this, we use the projection made in the previous section as a baseline for the period 2004 to 2020. After shocking one or more variables from a given year (2005) onwards, a new projection is produced. This new projection can be compared with the original baseline solution. Our interest is to understand the system-wide properties of the model when it is subjected to such exogenous shocks. The change relative to the baseline projection shows us the consequences of the shock over time. Out of the wide range of possible multipliers we present here four cases that are particularly important. These are:

- i. The effects of changes in world output/demand (i.e., the components of OW);
- ii. The effects of a rise in public employment (LG);
- iii. The effects of an increase in public investment (IGV);
- iv. The effects of a rise in the exogenous price levels;

### (i) A SHOCK TO WORLD OUTPUT (OW)

To investigate the effect of world output shocks on the model we permanently raised all the separate components that make up OW (a trade-weighted measure of manufacturing output in the main trading partners of the Czech Republic) by 10 percent above their baseline trajectories. It should be kept in mind that most of OW is accounted for by manufacturing output in the EU, with only a minor part from outside the EU. Hence, this is effectively a shock that explores the consequences for the Czech Republic economy of a rise in activity in its EU trading partners, where no other exogenous world variable is altered (e.g., unemployment, prices, etc.).

Table 6.6.1 shows the effect of this shock on total GDP, as well as on manufacturing sector output (OT), building and construction output (OBC) and market services sector output (OMS). The consequences for manufacturing (OT) stem largely from the calibration of the OT (manufacturing output) equation (where the elasticity of OT with respect to OW was 0.5). The impacts on building/construction and on market services arise as an indirect consequence of the external stimulus transmitted through the exposed trading sector.



Table 6.6.1:  
Effects of 10% rise in level of “world” output  
(percentage change relative to baseline)

Date	OW	OT	OBC	OMS	GDPFC
2004	0.00	0.00	0.00	0.00	0.00
2005	10.00	5.70	0.09	0.82	2.09
2006	10.00	4.99	0.25	0.89	1.92
2007	10.00	5.16	2.06	1.38	2.31
2008	10.00	4.95	2.00	1.32	2.23
2009	10.00	4.97	2.41	1.41	2.31
2010	10.00	4.90	2.37	1.37	2.28
2015	10.00	4.78	2.48	1.28	2.27
2020	10.00	4.69	2.48	1.19	2.25

OW: “world” output; GDPFC: real GDP at factor cost; OT: GDP in manufacturing; OBC: GDP in building & construction; OMS: GDP in market services

## (ii) A PUBLIC EMPLOYMENT SHOCK (LG)

Table 6.6.2 presents the model’s response to a sustained 10 percent increase in the number of employees in the public sector (LG). In levels, this amounts to an increase of about 8,510 new jobs in the sector. The increase in expenditure on public sector wages is financed by running a larger deficit (if necessary) and not by increasing tax rates or cutting public expenditure elsewhere.

As can be seen from Table 6.6.2, total employment increases initially by only 7,230 as a result of the Keynesian demand mechanism (i.e., when the extra public sector employees spend their wages). In other words, the impact multiplier is slightly less than unity. This steadily increases to about 8.890 at the end of the simulation period, indicating a Keynesian employment multiplier of about 1.045. We emphasise again that this simulation was run under the assumption that tax rates are exogenous and there is no additional fiscal crowding-out effect.<sup>38</sup>

<sup>38</sup> In refining the structure of the new Czech HERMIN, a change was made to the equation for market services output between the initial version and the final version used in this report. This is the main reason why the multiplier is lower than in the previous version of the model.

Table 6.6.2:  
**Effects of 10% increase in public sector employment**  
**(Change relative to baseline, thousands)**

Date	LG	L	Multiplier
2004	0	0	0
2005	8.51	7.23	0.849
2006	8.51	6.73	0.792
2007	8.51	8.38	0.985
2008	8.51	8.19	0.962
2009	8.51	8.60	1.010
2010	8.51	8.56	1.006
2015	8.51	8.79	1.033
2020	8.51	8.89	1.045

LG = employment in non-market services; L = total employment

In fact, given the strong revenue buoyancy, this shock is almost self-financing and the borrowing requirement (expressed as a share of GDP) does not change much relative to the “no shock” baseline. But it should be remembered that the size of the public sector has increased relative to the size of the private sector, and this is highly undesirable for other reasons.

### **(iii) A SHOCK TO GOVERNMENT INVESTMENT (IGV)**

The next shock we examine relates to an increase in public investment in infrastructure. Table 6.6.3 shows the effect of a permanent 10 percent increase in nominal public investment. As can be seen from Table 6.6.3, there is an initially modest Keynesian multiplier effect of less than unity (i.e., the change in real GDP (GDPE) divided by the shock to real public investment (IG)). The multiplier on GDP rises to 1.105 by the year 2010, and to 1.23 by the year 2020.

In the previous version of the HERMIN model, this multiplier was very large, and this suggested that the balance between production and absorption needed to be further examined. The alternation made to the equation for market services output (OMS) corrected this problem. Once again, we must stress that the extra public expenditure to support increased public investment is financed by running a higher regional deficit. So, there is no fiscal crowding out due to higher tax rates or higher interest rates.

Table 6.6.3:  
**Effects of a 10% rise in the level of public investment**  
**(change relative to baseline, real Czech Koruna (1995))**

Date	IG	I	GDPE	NTS	Multiplier
2004	0	0	0	0	0.000
2005	4375	5842	3817	-4267	0.872
2006	4258	6057	3560	-4914	0.836
2007	4206	6480	4560	-5075	1.084
2008	4170	6419	4388	-5154	1.052
2009	4147	6481	4623	-5159	1.115
2010	4124	6424	4556	-5160	1.105
2015	4017	6256	4648	-5149	1.157
2020	3899	6094	4786	-5236	1.227

IG = real public investment; I = total investment; GDPE = GDP (expenditure);  
 NTS = real net trade surplus

#### **(iv) A SHOCK TO ALL EXOGENOUS PRICE LEVELS**

Here we carry out a shock that raises the exogenous price levels permanently by 10 percent, mainly in order to test the price homogeneity that was imposed on the model. The prices involved are as follows: the price of agricultural output (POA); the price of manufacturing output in the world (with various subcomponents); and the import price (PM).

Table 6.6.4 shows the response of Czech Republic prices and costs. The delay in adjustment is due entirely to the very slow adjustment explicit in the calibrated equation for POBC, the deflator of building/construction output, and the phased adjustment of prices in market services.

Table 6.6.4:  
**Effects of 10% increase in all exogenous price levels**  
 (percentage change relative to baseline)

Date	PWORLD	POT	POMS	PCONS	WT	ULCT	RULCT
2004	0	0	0	0	0	0	0
2005	10.00	9.27	5.51	7.01	7.61	7.60	-1.53
2006	10.00	9.20	7.39	8.20	7.29	7.36	-1.68
2007	10.00	9.66	8.44	9.01	8.84	8.86	-0.73
2008	10.00	9.64	8.80	9.25	8.78	8.80	-0.76
2009	10.00	9.77	9.11	9.48	9.22	9.24	-0.49
2010	10.00	9.79	9.26	9.58	9.27	9.29	-0.46
2015	10.00	9.93	9.73	9.89	9.75	9.75	-0.16
2020	10.00	9.99	9.94	10.03	9.95	9.96	-0.02

PWORLD = World price; POT = manufacturing output deflator; PON = market services output deflator;  
 PCONS = Consumption deflator; WT = Average annual earnings in manufacturing;  
 ULCT = unit labour costs, manufacturing; RULCT: Real unit labour costs, manufacturing

## (v) CONCLUSIONS ON RESPONSES TO SHOCKS

The shocks illustrate some of the properties of the new five-sector version of the Czech Republic HERMIN model. World market conditions feed into the economy of the Czech Republic mainly through the internationally exposed manufacturing sector but also indirectly through the market services sector. External price shocks pass quickly into domestic prices, under the assumption of a fixed exchange rate. Public employment and investment shocks have relatively modest impacts on the economy. However, it must be recognised that the public employment (LG) and public investment (IGV) shocks impact mainly on the demand side of the economy. In the next section we show how these demand-side (or Keynesian) impacts can be augmented through supply-side productivity-enhancing effects that are associated with EU Structural Funds.

The above set of tests serve to alert us to the importance of the market services and building and construction sectors (i.e., the mainly non-traded sectors). The latter is destined to play a major role in the implementation of the physical infrastructure investment programmes of the Czech Republic NESF, which will absorb a high proportion of the NSRF funding.

---

## COMPUTER IMPLEMENTATION OF THE HCZ5 MODEL SYSTEM

### 7.1 THE SOFTWARE

The following software packages are needed to implement and work with the new Czech republic HERMIN HCZ5 model system:

- a) A text editor to prepare text/data files for use in TSP. WordPad is adequate, but a more sophisticated text editor (like TextPad) is preferable.
- b) The TSP database and econometric package for use in computerising the input data, and carrying out the model calibration exercises ([www.tspintl.com](http://www.tspintl.com)).
- c) The WINSOLVE model simulation package ([www.econ.surrey.ac.uk/winsolve/](http://www.econ.surrey.ac.uk/winsolve/)) for use in model simulation.
- d) MS Excel, to handle spreadsheets in preparing the data, and in extracting tables from model simulation results.
- e) MS Word, or some other compatible word processor, to prepare documentation, reports, etc.

### 7.2 ORGANISATION OF THE COMPUTER FILES AND FOLDERS

Because many of the operations with the new model take place through the use of TSP and WINSOLVE batch files, care has to be given to how the model system is set up on the computer. The batch files often need to make explicit reference to where files are physically located on the computer disk. To handle this, the following convention is applied.

All operations with the HCZ5 model system take place in the following sub-directory:

C:\SIM\HCZ5

If the computer cannot operate with a "C:\" drive designation, then the batch files will need to be altered before they will run successfully.

### 7.3S IMULATING THE MODEL SYSTEM

Annex 6 and 7 contain listings of the key model simulation files. These are used by WINSOLVE, and always have the file extension "log". When starting up simulations, these should be executed in the following order:

- a) Consistency checking simulation: HCZ5HIST.log
- b) Projection of exogenous variables: HCZ5PROD0.log
- c) Baseline projection: HCZ5PROD1.log
- d) The model "shock" simulations (in any order)
- e) The NSRF simulations (after the definition of the baseline projection, executed by HCZ5PROD1.log above)

Each of these files can be easily executed from within WINSOLVE. The sequence of running a batch file is as follows:

- a) Load WINSOLVE (by double clicking on the WINSOLVE icon on the desk-top)
- b) Load the model file (HCZ5.TXT) using the "open model" icon on the menu line
- c) Load the historical database (HCZ5.SDF) using the "open data file" icon on the menu line
- d) Run the appropriate WINSOLVE "log" file using the "file" and "run log file" menu items from the "file" menu

If the model executes successfully, then the user has access to all the output results. Using the "results" menu, a wide range of reports can be generated. A popular way to examine initial simulation results is to use the "graph" and "table" options, and examine the results interactively. If this examination is satisfactory, the "results" menu can be used to extract results to spreadsheets, where they can be examined at leisure, and incorporated into reports.

## **PART II: THE NSRF EVALUATION**

---

## NSRF EX-ANTE ANALYSIS WITH THE NEW MODEL

### 8.1 INTRODUCTION

The structure of the HCZ5 HERMIN model was designed to facilitate the macro evaluation of the impacts of an NSRF, and its associated Structural Funds. Comprehensive accounts of the evolution of the impact evaluation methodology are available elsewhere (see Bradley, Kangur and Lubenets, 2004, for a complete set of references). In this section we confine ourselves to repeating the practical model-related aspects of the NDP evaluation methodology, in order to explain to a potential user of the model how it is implemented.

We first describe the way in which the NSRF Financial tables, as published in the NDP document, can be computerised in a flexible way. In other words, we handle the situation where the total sum of EC finance may change, and where its distribution across various types of public investment categories can also change.

We then summarise the computer mechanisms through which the NSRF impacts are modelled, and describe the type of information that will be needed if the impact evaluation is to be carried out as accurately as possible.

### 8.2 INSERTING THE NSRF INTO THE NEW MODEL

In its most simple form, the NSRF data as negotiated with the EC would consist of time series for the total Community (EC) funding allocation to each recipient state, expressed in millions of euro (in constant 2006 prices, at the time of writing). In each country/region, the HERMIN notation for these basic data is GECSFEC\_RE, and they are given for the years 2007-2013 inclusive.<sup>39</sup>

The constant 2006 price data series GECSFEC\_RE for each recipient country are converted to current prices (GECSFEC\_E) by assuming appropriate inflation rates per year from 2006 onwards. This assumption can, of course, be changed in the light of circumstances. These data must then be converted into the local (Czech) currency. Fixed exchange rates relative to the euro are assumed.

As part of the negotiations with the European Commission, a domestic co-finance ratio is agreed. The DP percentage (i.e., 15%) is designated as RDCOFIN in the formulae below.

The total (EC+DP) expenditure is then split between the three main economic categories using the national shares implicit in the detailed sectoral and regional Operational Pro-

---

<sup>39</sup> If the expenditures are planned to continue after the year 2013 (under the so-called “n+2” rule), then additional data are needed.



grammes contained in the national NSRF document: i.e., physical infrastructure, human resources, and direct aid to the productive sectors.

The further allocation of the direct aid to productive sectors (as between manufacturing and market services, since no funds will be devoted to agriculture, post-2006) is carried out using assumed shares, since these data are not yet available in the Czech NSRF.

In the present Czech analysis, the EC total expenditure contribution for each of the years 2007 to 2013 in current euro is input as a datum (GECSFEC\_E). Using the seven-year total, and the published distribution of expenditure by year, the data are derived for the seven years of NSRF 2007-2013. This is converted to national currency (GECSFEC) using exchange rate (CZKEUR)<sup>40</sup>

$$\text{GECSFEC} = \text{GECSFEC\_E} * \text{CZKEUR}$$

The implied domestic (DP) co-finance contribution (GECSFDP), is derived using an assumed domestic co-finance ratio (RDCOFIN percent)

$$\text{GECSFDP} = (\text{RDCOFIN}/(100-\text{RDCOFIN})) * \text{GECSFEC}$$

Total (EC+DP) expenditure (GECSF) is defined as:

$$\text{GECSF} = \text{GECSFEC} + \text{GECSFDP}$$

This is then disaggregated into the three main economic categories.

- (a) Physical infrastructure (IGVCSFXX)
- (b) Human Resources (GTRSFXX), and
- (c) Direct Aid to the Productive Sector (TRIXX),

where XX=EC (Community) or DP (Domestic Public) contribution.

The percentage share going to physical infrastructure is RIGVCSF; the share going to human resources is RGTRSF. The residual goes to direct aid to the productive sector.

### **Physical infrastructure:**

$$\text{IGVCSFEC} = (\text{RIGVCSF}/100) * \text{GECSFEC}$$

---

<sup>40</sup> A value of 28.34 Czech koruna per euro is assumed (the rate on October 20<sup>th</sup>, 2006).

$$\text{IGVCSFDP} = (\text{RIGVCSF}/100) * \text{GECSFDP}$$

**Human resources:**

$$\text{GTRSFEC} = (\text{RGTRSF}/100) * \text{GECSFEC}$$

$$\text{GTRSFDP} = (\text{RGTRSF}/100) * \text{GECSFDP}$$

**Direct aid to the productive sectors:**

$$\text{TRIEC} = \text{GECSFEC} - (\text{IGVCSFEC} + \text{GTRSFEC})$$

$$\text{TRIDP} = \text{GECSFDP} - (\text{IGVCSFDP} + \text{GTRSFDP})$$

Direct aid to the productive sectors (TRIXX) is disaggregated into its two main sectoral allocations (manufacturing (T) and Market Services (M) ).

Manufacturing (Percentage share = RTRIT):

$$\text{TRITEC} = (\text{RTRIT}/100) * \text{TRIEC}$$

$$\text{TRITDP} = (\text{RTRIT}/100) * \text{TRIDP}$$

Market Services (residual):

$$\text{TRIMSEC} = \text{TRIEC} - \text{TRITEC}$$

$$\text{TRIMSDP} = \text{TRIDP} - \text{TRINEC}$$

The private co-finance ratio (relative to GECSFEC) is RPVTRI. We use this ratio to calculate private APS co-finance (TRIPR):

$$\text{TRIPR} = (\text{RPVTRI}/100) * \text{GECSFEC} ;$$

We then disaggregate Direct Aid to the Productive Sector (APS) into its two sectoral allocations to Manufacturing (T) and Market Services (MS). We assume a fixed proportion across all three types of finance (EC, DP and PR). We exclude transfers to agriculture.

APS to Manufacturing (Percentage share = RTRIT):

$$\text{TRITEC} = (\text{RTRIT}/100) * \text{TRIEC}$$

$$\text{TRITDP} = (\text{RTRIT}/100) * \text{TRIDP}$$

$$\text{TRITPR} = (\text{RTRIT}/100) * \text{TRIPR}$$

APS to Market Services (defined as the residual):

$$\text{TRIMSEC} = \text{TRIEC} - \text{TRITEC}$$

$$\text{TRIMSDP} = \text{TRIDP} - \text{TRITDP}$$

$$\text{TRIMSPR} = \text{TRIPR} - \text{TRITPR}$$

We make the assumption that any investment in research and development (R&D) is contained in the APS Operational Programmes. We disaggregate total APS into two main economic categories; R&D and other direct aid. The percentage share of TRIEC, TRIDP and TRIPR going to R&D is RRDTCSF. We then use RRDTCSF to calculate total expenditure from APS going to fund R&D (TRIRD). The accumulation of the constant price version of TRIRD (i.e., RTRIRD) is used later to derive a measure of a "stock" of R&D (KRTRIRD)

$$\text{TRIRD} = (\text{RRDTCSF}/100) * (\text{TRIEC} + \text{TRIDP} + \text{TRIPR});$$

### 8.3 THE NSRF IMPACT METHODOLOGY FOR THE NEW HCZ5 MODEL

#### (i) HANDLING NSRF PHYSICAL INFRASTRUCTURE IMPACT ANALYSIS

The HERMIN model assumes that any NSRF-based expenditure on physical infrastructure that is directly financed by EC aid subvention (IGVCSFEC) is matched by a domestically financed public expenditure (IGVCSFDP) and a domestic privately financed component (IGVCSFPR).<sup>41</sup> Hence, the total public and private NSRF infrastructure expenditure (IGVCSF) is defined in the model as follows (in current prices):

$$\text{IGVCSF} = \text{IGVCSFEC} + \text{IGVCSFDP} + \text{IGVCSFPR}$$

Inside the HERMIN model, these NSRF-related expenditures are converted to real terms (by deflating the nominal expenditures by the investment price) and are then added to any existing (non-NSRF) real infrastructure investment, determining total real investment in infrastructure (IGINF). Using the perpetual inventory approach, these investments are accumulated into a notional 'stock' of infrastructure (KGINF):

---

<sup>41</sup> The notation used in the model originated in earlier years, when the NDP, as implemented, was referred to as the Community Support Framework (or CSF). So, the letters "CSF" in variables like IGVCSF, are not now appropriate. But in what follows we have left the notation unchanged, but, of course, the appropriate concepts are being used.

$$KGINF = IGINF + (1-0.02) * KGINF(-1)$$

where a 2 per cent rate of stock depreciation is assumed. This accumulated stock is divided by the (exogenous) baseline non-NSRF stock ( $KGINF_0$ ) to give the NSRF-related relative improvement in the stock of infrastructure (KGINFR):

$$KGINFR = KGINF / KGINF_0$$

It is this ratio that enters into the calculation of any externalities associated with improved infrastructure, as described above.

As regards the public finance implications of the NSRF, the total cost of the increased public expenditure on infrastructure ( $IGVCSF - IGVCSFPR$ ) is added to the domestic public sector capital expenditure (GK). Any increase in the domestic public sector deficit (GBOR) is limited by the extent of EC NSRF-related aid subventions ( $IGVCSFEC$ ). Whether or not the post-NSRF public sector deficit rises or falls relative to the no-NSRF baseline will depend both on the magnitude of domestic co-financing and the stimulus imparted to the economy by the NSRF shock. This differs from country to country as well as from programme to programme.

In the complete absence of any externality (or spillover) mechanisms, the HERMIN model calculates the demand (or Keynesian) effects of the NSRF infrastructure programmes, the supply effects being only included to the very limited extent that they are captured by any induced shifts in relative prices. This transitory effect will depend on the size of the policy multipliers, which will be known from the testing results of any specific country HERMIN model.

We can now switch in various externality effects to augment the conventional demand-side impacts of the NSRF infrastructure programmes in order to capture likely additional supply-side benefits. In each case, the strength of the externality effect is defined as a fraction of the improvement of the stock of infrastructure over and above the baseline (no-NSRF) projected level (KGINFR), i.e.,

$$\text{Externality effect} = KGINFR^\eta$$

where  $\eta$  is the externality elasticity. The way in which the externality elasticity can be approximately calibrated numerically, drawing on the empirical growth theory research literature (see Bradley, Kangur and Lubenets, 2004 for details). In any model-based simulations, the externality effects can be phased in linearly over an extended period, reflecting the implementation stages of the NSRF programmes and the fact that benefits from improved infrastructure may only be exploited with a lag by the private sector in terms of increased activity.

Externality effects associated with improved infrastructure are introduced into the following areas of the HERMIN model:

- i. The direct influence on manufacturing output (OT) of improved infrastructure (KGINF), i.e. any rise in the stock of infrastructure relative to the no-NSRF baseline (KGINFR) will be reflected in a rise in output.
- ii. Total factor productivity (TFP) in manufacturing (T) as well as in market services (MS) is increased

The first type of externality is an unqualified benefit to the economy, and directly enhances its performance in terms of increased manufacturing sub-sector output for given inputs. However, the second type is likely to have a negative down-side, in that labour is shed as total factor productivity improves, unless output can be increased to offset this loss. Inevitably production will become less labour intensive in a way that may differ from the experience of more developed economies in the EU core.

## (ii) HANDLING NSRF HUMAN RESOURCES IMPACT ANALYSIS

The HERMIN model assumes that any NSRF expenditure on human resources directly financed through the European Social Fund (ESF) by the EU (GTRSFEC) is matched by a domestically financed public expenditure (GTRSFDP). Hence, the total expenditure on human resources (GTRSF) is defined in the model as follows (in current prices):

$$GTRSF = GTRSFEC + GTRSFDP$$

As regards the public finance implications for any Objective 1 country, the total cost of the increased expenditure on human resources (GTRSFEC+GTRSFDP) is added to public expenditure on income transfers (GTR). However, the increase in the domestic public regional deficit (GBOR) is limited by the extent of CSF aid subventions (GTRSFEC).

Since the complex institutional detail of the many ESF human resource training and education programmes cannot be handled in a small macroeconomic model like HERMIN, one needs to simplify drastically. Each trainee or participant in a training course is assumed to be paid an average annual income (WTRAIN), taken to be a fraction of the average industrial wage (WT). Each instructor is assumed to be paid the average annual wage appropriate to the aggregate market service sector (WN). We assume an overhead on total wage costs to take account of buildings, equipment, materials, etc (OVERHD), and a trainee-instructor ratio (TRATIO).<sup>42</sup> Hence, total CSF expenditure (GTRSF) can be written as follows (in nominal terms):

$$GTRSF = (1+OVERHD) * (SFTRAIN*WTRAIN + LINS*WN)$$

<sup>42</sup> Standard parameter values of OVERHD=0.50, TMUP=0.50 and TRATIO=15 are initially assumed, but these can be modified as more detailed information becomes available.

where SFTRAIN is the number of trainees being supported and LINS is the number of instructors, defined as SFTRAIN/TRATIO.<sup>43</sup> This formula is inverted in the HERMIN model and used to estimate the approximate number of extra trainees that can be funded by the CSF for a given total expenditure GTRSF on human resources, i.e.,

$$\text{SFTRAIN} = (\text{GTRSF}/(1+\text{OVERHD})) / (\text{WTRAIN} + \text{WN}/\text{TRATIO})$$

The wage bill of the CSF programme (SFWAG) is as follows:

$$\text{SFWAG} = \text{SFTRAIN} * \text{WTRAIN} + \text{LINS} * \text{WN}$$

The number of NSRF-funded trainees (measured in trainee-years) is accumulated into a 'stock' (KSFTRAIN) by means of a perpetual inventory-like formula, with a 'depreciation' rate of 5 per cent:

$$\text{KSFTRAIN} = \text{SFTRAIN} + (1-0.05) * \text{KSFTRAIN}(-1)$$

In order to quantify the increase in the stock of human capital (measured in trainee years), we need to define the initial pre-NSRF stock of human capital, KTRAIN<sub>0</sub>. This is a conceptually difficult challenge, and we are again forced to simplify drastically. We base our measure of human capital on the average number of years of formal education and training that the labour force has achieved prior to the NSRF. We can cut through the complex details of the education system and stylise it as follows:

$$\begin{aligned} \text{KTRAIN}_0 = & \text{YPLS} * \text{FPLS} * \text{DPLS} + \text{YHS} * \text{FHS} * \text{DHS} \\ & + \text{YNUT} * \text{FNUT} * \text{DNUT} + \text{YUT} * \text{FUT} * \text{DUT} \end{aligned}$$

where the notation is as follows:

YPLS = standardised number of years in primary and lower secondary cycle

FPLS = fraction of population with primary and lower secondary cycle education

DPLS = "discount" factor for years of primary and lower secondary cycle<sup>44</sup>

<sup>43</sup> Even if we were able to obtain full details of the inputs and outputs of the ESF training schemes, the HERMIN-type simplification would still be of use since it "endogenises" the ESF schemes in the macro impact simulations in a way that would be very difficult to do with the ex-post ESF data.

<sup>44</sup> The reason for including a "discount" factor is as follows. Although many studies assume that a single year of primary cycle education adds as much to human capital (and is as valuable a contribution as an input to productive working activity), as one year of

YHS = standardised number of years higher secondary cycle

FHS = fraction of population with higher secondary education

DHS = “discount” factor for years of higher secondary cycle

YNUT = standardised number of years in non-university tertiary cycle

FNUT = fraction of population with non-university tertiary education

DNUT = “discount” factor for years of non-university tertiary cycle

YUT = standardised number of years in university tertiary cycle

FUT = fraction of population with university tertiary cycle

DUT = “discount” factor for years university tertiary cycle

The accumulated stock of NSRF trainees (KSFTRAIN) is added to the exogenous baseline stock of trained workers (KTRAIN<sub>0</sub>) and is divided by the baseline stock to give the relative improvement in the proportion of trained workers associated with the NSRF human resources programmes:

$$KTRNR = (KTRAIN_0 + KSFTRAIN) / KTRAIN_0$$

and it is this ratio (KTRNR) that enters into the calculation of externalities associated with improved human resources.

In the absence of any externality mechanisms, the HERMIN model can only calculate the income-expenditure effects of the NSRF human resource programmes. These effects are limited in magnitude. In addition, a sizeable fraction of the NSRF payments to trainees may simply replace existing unemployment transfers. The ‘overhead’ element of these programmes (equal to OVERHD\*SFWAG) is assumed to boost non-wage public consumption directly.

The HERMIN model introduces externality effects to augment the demand-side impacts of the NSRF human resource programmes. In each case, the strength of the externality effect is defined as a fraction of the improvement of the stock of ‘trained’ workers over and above the baseline (no-NSRF) projected level, i.e.,

---

university education, this is very unlikely to be true. Adding up the years of education without weighting them is likely to bias the level of human capital upwards. For example, since primary and lower secondary level education is becoming the norm throughout the EU, we might discount these years relative to years of higher secondary, tertiary non-university and tertiary university. If one sets the discount factor to zero, this is equivalent to assuming that primary and lower secondary education is a prerequisite for acquiring human capital, and not a part of productivity-enhancing human capital.

$$\text{Externality effect} = \text{KTRNR}^{\eta}$$

here  $\eta$  is the externality elasticity. In the model-based simulations, the externality effects can be phased in linearly over an extended period, reflecting the implementation stages of the NSRF programmes and the fact that benefits from improved infrastructure may only be exploited with a lag by the private sector in terms of increased activity.

Two types of externality effects associated with human capital are introduced into the HERMIN model:<sup>45</sup>

- i. The direct influence on manufacturing output (OT) of improved human capital, i.e. any rise in the “stock” of human capital relative to the no-NSRF baseline (proxied by KTRNR) will be reflected in a rise in output.
- ii. Labour embodied technical change in manufacturing (T) and in market services (MS) is increased, where a given output can now be produced by less workers or where any increased level of sectoral output can become more skill intensive but less employment intensive.

### **(iii) HANDLING NSRF RESEARCH AND DEVELOPMENT (R&D) IMPACT ANALYSIS**

The HERMIN model assumes that any NSRF-based expenditure on R&D that is directly financed by EC aid subvention is matched both by a domestically financed public expenditure and a (significantly large) domestic privately financed component. The APS (direct aid to productive sectors) injection of EU funding (TRIEC) is accompanied by a national public counterpart (TRIDP) and a private sector counterpart (TRIPR). Only part of total APS (i.e., TRI) consists of R&D expenditures (i.e., TRIRD).

Hence, the total public and private NSRF infrastructure expenditure (IGVCSF) is defined in the model as follows (in current prices):

$$\text{TRIRD} = (\text{RRDTCSF}/100) * (\text{TRIEC} + \text{TRIDP} + \text{TRIPR})$$

Inside the HERMIN model, these NSRF-related expenditures are converted to real terms (by deflating the nominal expenditures by the consumption price) and are then added to any

---

<sup>45</sup> It is well known that untrained and/or unskilled workers compete in the labour market in a very ineffective way, and are much more likely to end up as long-term unemployed than are skilled/trained workers (Layard, Nickell and Jackman, 1991). We assume that all ESF trainees are in the unskilled or semi-skilled category, and that their temporary removal from the labour force for the duration of their training scheme has almost no effect on wage bargaining behaviour through the Phillips curve ‘pressure’ effect in the HERMIN wage equation.



existing (non-NSRF) real R&D investment, determining total real investment in R&D (RTRIRD).

We accumulate the real TRIRD expenditures (RTRIRD) deflating by the consumption price) to obtain a stock of R&D (KRTRIRD). However, when it comes to the public sector accounts, we exclude TRIPR from public NSRF capital expenditure (GEKCSF).

We define total "real" R&D investment expenditures as the sum of real non-ROP R&D investments (RRANDD) and additional ROP R&D investments (TRIRD/PCONS)

$$RTRIRD = RRANDD + TRIRD/PCONS$$

R&D investment is accumulated into a notional stock (KRTRIRD) by a perpetual inventory formula, assuming an 8% depreciation rate.

$$KRTRIRD = RTRIRD + (1-0.08)*KRTRIRD_{-1}$$

The new (augmented) stock of R&D (KRTRIRD) is related to a baseline ex-ante stock (KRTRIRD<sub>0</sub>). Spillovers are associated with increases in this ratio (KRTRIRD<sub>R</sub>).

$$KRTRIRD_R = KRTRIRD / KRTRIRD_0$$

It is this ratio that enters into the calculation of any externalities (spillovers) associated with an improved stock of R&D, as described above.

As regards the public finance implications of the NSRF, the total cost of the increased public expenditure on R&D is added to the domestic public sector capital expenditure (GK). Any increase in the domestic public sector deficit (GBOR) is limited by the extent of EC NSRF-related aid subventions. Whether or not the post-NSRF public sector deficit rises or falls relative to the no-NSRF baseline will depend both on the magnitude of domestic co-financing and the stimulus imparted to the economy by the NSRF shock.

In the complete absence of any externality (or spillover) mechanisms, the HERMIN model calculates the demand (or Keynesian) effects of the NSRF R&D programmes, the supply effects being only included to the very limited extent that they are captured by any induced shifts in relative prices. This transitory effect will depend on the size of the policy multipliers, which will be known from the testing results of any specific country HERMIN model.

We can now switch in various externality effects to augment the conventional demand-side impacts of the NSRF R&D programmes in order to capture likely additional supply-side benefits. In each case, the strength of the externality effect is defined as a fraction of the improvement of the stock of R&D over and above the baseline (no-NSRF) projected level (KRTRIRD<sub>R</sub>), i.e.,

$$\text{Externality effect} = KRTRIRD_R^{\eta}$$

where  $\eta$  is the externality elasticity. The way in which the externality elasticity can be approximately calibrated numerically, drawing on the empirical growth theory research literature (see CBO, 2005 for details). In any model-based simulations, the externality effects can be phased in linearly over an extended period, reflecting the implementation stages of the NSRF programmes and the fact that benefits from improved R&D may only be exploited with a lag by the private sector in terms of increased activity.

Externality effects associated with improved R&D are introduced into the following areas of the HERMIN model:

- i. The direct influence on manufacturing output (OT) of improved R&D (KRTRIRD), i.e. any rise in the stock of R&D relative to the no-NSRF baseline (KRTRIRD<sub>R</sub>) will be reflected in a rise in output.
- ii. Total factor productivity (TFP) in manufacturing (T) as well as in market services (MS) is increased

As in the case of the other spillovers (from stocks of physical infrastructure and human capital), the first type of externality above (i) is an unqualified benefit to the economy, and directly enhances its performance in terms of increased manufacturing sub-sector output for given inputs. However, the second type (ii) is likely to have a negative down-side, in that labour is shed as total factor productivity improves, unless output can be increased to offset this loss. Inevitably production will become less labour intensive in a way that may differ from the experience of more developed economies in the EU core.

---

## THE NSRF IMPACT RESULTS

### 9.1 INTRODUCTORY REMARKS

The task is to evaluate the impacts of NSRF 2007-2013, treating it as a single, unified investment programme that extends over seven years from 2007 to the termination of the payments in 2013.

An important point concerning the NSRF data should be stressed. It is the accepted practice in the Commission evaluations carried out by DG-REGIO to remove the national private co-finance from consideration in impact analysis. The reason for this is that the private co-finance arises mainly through the reactions of the private sector to the public (EU plus national) investment policy actions. To include the private co-finance (and associated investment expenditures) separately would imply an element of double counting of the private sector effects. To avoid this double counting, we excluded the private sector co-finance data from the NSRF totals provided by the Ministry, with one important exception: the funding of R&D.

In the case of direct aid to the productive sectors, there is sometimes a very significant element of private co-finance. In this case, the provision of private co-finance is a mandatory requirement to ensure access to the public funding to support R&D. For this category of NSRF funding we include the private co-finance. Hence, the real expenditure on R&D includes all three financial elements (EC, domestic public and domestic private).

### 9.2 OTHER TECHNICAL ASSUMPTIONS MADE IN PREPARING THE SIMULATIONS

With the exception of the exchange rate, we retained the other basic assumptions that were made in many previous ex-ante impact analysis of Structural Funds. The most important assumption – insofar as it affects the impact outturn – concerns the so-called spillover parameters. These are designed to capture the benefits of the improved stocks of physical infrastructure, human capital and R&D in boosting output and productivity during the implementation stage and after the NSRF programme ends in 2013.

On the basis of our examination of the NSRF background documents, we have assumed that the direct output spillovers from infrastructure and human capital in manufacturing are at the mid-range of the international scale, i.e., 20 per cent.<sup>46</sup> In the case of spillovers from

---

<sup>46</sup> For example, this means that a 1 per cent increase in the stock of physical infrastructure will generate a 0.2 per cent increase in the level of GDP, other things being equal.

increased stocks of R&D, we assume values at the lower end of the international findings, i.e., 5 per cent

For physical infrastructure, the productivity spillovers are assumed to be in the mid-range of international experience, i.e., 10 per cent both for manufacturing and for market services.<sup>47</sup> Once again, in the case of R&D productivity spillovers, we assume lower values of 2.5 per cent.<sup>48</sup>

All other technical assumptions are unchanged, e.g., trainee/instructor ratios, training scheme overheads, etc. Details are available on request.

### 9.3 OVERVIEW OF MAIN NSRF IMPACTS

In this section we present a very brief overview of the impacts of the NSRF on aggregate GDP, aggregate employment and aggregate productivity. In the case of aggregate GDP impacts, one must make a very clear distinction between the impacts of the NSRF on the growth rate (which are transitory) and the impacts on the level of GDP (which are of a more long-lasting character).

Using the “without-NSRF” baseline projection described in Section 8 above, we then set the NSRF public expenditures at the levels described in the official NSRF documents. The “without-NSRF” baseline is compared with the “with-NSRF” simulation, and any differences are as a measure of the NSRF impacts. These differences are usually expressed as percentage changes relative to the baseline, but can also be expressed as absolute differences from the baseline.

The detailed simulation results are presented in the following section. Clearly there is a large amount of information contained in the tables in the next section, and great care has to be exercised to ensure that the tables are interpreted correctly and accurately. In this section, we present summary results and a brief explanation of the variable notation.

The following notation is used:

- i. Where (p) is shown beside the variable name, this means that the results are percentage changes relative to the “without-NSRF” baseline;

---

<sup>47</sup> For example, a one per cent increase in the stock of physical infrastructure will generate a 0.2 percent increase in manufacturing productivity, but only a 0.1 percentage increase in productivity in market services.

<sup>48</sup> As documented in CBO (2005), there is considerable uncertainty surrounding spillovers from increased R&D, so we feel that conservative values are more appropriate. These assumptions can be revised later, when more information on the exact nature of the R&D becomes available.

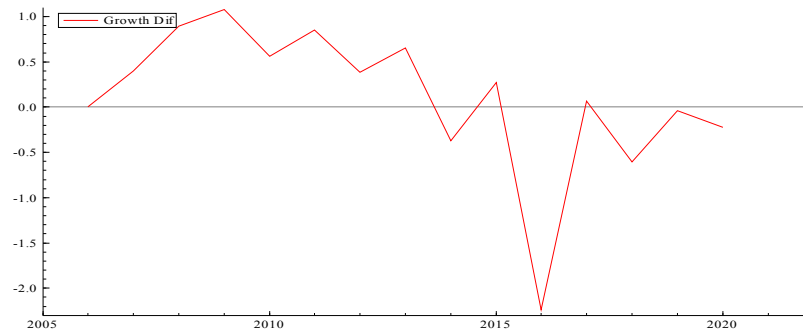
- ii. Where (g) is shown beside a variable name, this indicates that a simple annual growth rate is shown (i.e., growth in the variable over time, and NOT relative to any baseline);
- iii. Where (l) is shown beside a variable name, this indicates a level of the variable in the “with NSRF” simulation;
- iv. Where (d) is shown beside a variable name, this indicates a difference relative to the baseline. For example, “L(d)” indicates that this is the change in numbers employed (expressed in thousands) in the “with-NSRF” simulation relative to the “without-NSRF” simulation.

### Box 9.3.1: Presenting the impact of the NSRF

There are two different ways of presenting the impact of an NSRF on economic variables. In the case of aggregate GDP, one must make a very clear distinction between the impacts of the NSRF on the growth rate (which are transitory) and the impacts on the level of GDP (which are of a more long-lasting character).

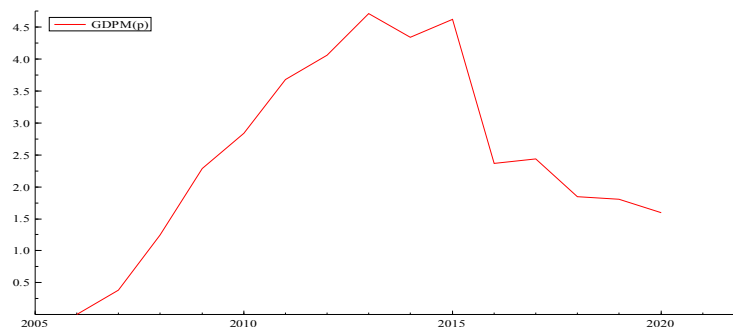
In Figure 9.3.1 we show the baseline growth rate of aggregate GDP (i.e., the “without-NSRF case”), and the growth rate of aggregate GDP in the “with-NSRF” case. The most notable feature is that with a more gradual phasing in of the NSRF expenditures (compared to the “abrupt” start of the first analysis), the NSRF is likely to cause a more gradual increase rise in the growth rate in the start-up year 2007. The other notable feature is the large negative shock to the growth rate experienced in the year 2016, due to the assumed sudden termination of the NSRF funding after 2015, when it was at a peak. For the intermediate years 2008-2013, there are further modest increments to the growth rate. After the year 2016, the “with-NSRF” growth rate quickly converges back to the baseline “without-NSRF” growth rates.

Figure 9.3.1: Impacts of the NSRF on the growth rate of GDP



But the cohesion objective is usually expressed in terms of comparative “levels” of GDP per head. In Figure 9.3.2 we illustrate the NSRF impacts on the level of GDP. Here, we see the gradual rise in the level of GDP relative to the “without-NSRF” baseline level, from the start-up year 2007. Thereafter, there is a gradual build-up in the level increase until the abrupt termination of the NSRF after the year , 2015, by which point the level of GDP is nearly 4.5 per cent per cent higher than the “without-NSRF” case. After the NSRF funding is terminated at the end of 2015, there is a downward adjustment in the level of GDP, but by the year 2020 the level of GDP is still over 1.5 per cent higher than the “without-NSRF” case.

Figure 9.3.2: Impacts of the NSRF on the level of GDP



In Table 9.3.1 we present the baseline growth rate of aggregate GDP (i.e., the “without-NSRF case”), and the growth rate of aggregate GDP in the “with-NSRF” case. The most notable feature is that the NSRF is likely to cause a gradual rise in the growth rate from the start-up year 2007, the year of first implementation. In 2007, the “with-NSRF” growth rate is nearly 4.7%, while the baseline scenario “without-NSRF” growth rate is 4.3%, i.e., an increment of 0.4 percentage points. The other notable feature is the negative shock to the growth rate experienced in the year 2016 (minus 2.2 percentage points), due to the assumed complete cessation of the NSRF funding after December 31<sup>st</sup>, 2015.

Table 9.3.1:  
NSRF impacts on the GDP growth rate

Date	GDPM (g)	GDPM0 (g)	Growth Difference
2007	4.68	4.28	0.40
2008	5.00	4.11	0.90
2009	5.29	4.21	1.08
2010	4.75	4.18	0.56
2011	5.08	4.22	0.85
2012	4.61	4.23	0.38
2013	4.90	4.25	0.65
2014	3.88	4.25	-0.37
2015	4.54	4.26	0.27
2016	2.03	4.27	-2.24
2017	4.34	4.28	0.07
2018	3.68	4.28	-0.60
2019	4.25	4.29	-0.04
2020	4.07	4.29	-0.22

Between the year 2008 and 2013 there are significant increases to the “with-NSRF” growth rate relative to the “without-NSRF” growth rate. After the year 2016, the “with-NSRF” and “without-NSRF” growth rates are almost identical.

It should be stated that this conclusion is due entirely to the fact that the Czech NSRF in this revised simulation is now phased in a manner that causes a more gradual build-up in the expenditure programmes, compared to the previous more “abrupt” start-up. The previously proposed expenditure pattern assumed that approximately one seventh of the funds would be spent each year. Consequently, there would have been a big, positive shock to the growth rate in 2007, and a corresponding negative shock in the year 2014 (when the NSRF

was originally going to terminate). However, on balance, the aggregate of all the growth increments (relative to the “no-NSRF” case), is positive for both cases..

This last point is illustrated in Table 9.3.2, where we present the NSRF impacts on the level of GDP. Here, we see the gradual rise in the level of GDP from the initial year 2007 (a rise of 0.4 per cent, relative to the “without-NSRF” baseline level). Thereafter, there is a gradual build-up in the level increase until the termination of the NSRF in the year , 2015, by which point the level of GDP is 4.6 per cent higher than the “without-NSRF” case. After the NSRF funding ends in December 2015, there is a downward adjustment in the level of GDP, and by the year 2020 the level of GDP is still 1.6 per cent higher than the “without-NSRF” case.

Table 9.3.2:  
NSRF impacts on the level of GDP

Date	GDPM (p)
2006	0.00
2007	0.38
2008	1.24
2009	2.29
2010	2.84
2011	3.69
2012	4.07
2013	4.72
2014	4.35
2015	4.62
2016	2.37
2017	2.44
2018	1.84
2019	1.81
2020	1.59

In Table 9.3.3 we present the NSRF impacts on total employment numbers (expressed in thousands). The initial effect is to increase total employment by about 20 thousand jobs. This builds up to 180 thousand jobs by the year 2015, and in 2016 there is a sharp downward adjustment in the employment gain (from 180 thousand to 56 thousand), as the NSRF funding ceases and there are direct and indirect job lay-offs.<sup>49</sup> By the year 2020, i.e., five

<sup>49</sup> We stress that this is an “other things being equal” simulation. It ignores the likelihood that there will be a continuation NSRF after 2013, and/or that the domestic public authorities might substitute a purely nationally funded programme for the terminated EC-funded one.



years after the termination of the NSRF, the level of total employment is higher than in the without-NSRF baseline by 29 thousand.

Table 9.3.3:  
NSRF impacts on the level of total employment

Date	L (d)
2006	0.00
2007	19.66
2008	62.85
2009	111.57
2010	130.05
2011	159.31
2012	170.80
2013	196.28
2014	169.03
2015	177.81
2016	55.91
2017	63.62
2018	34.33
2019	36.72
2020	28.61

Finally, in Table 9.3.4 we present the NSRF impacts on the level of labour productivity (i.e., aggregate GDP per worker). This is a crucial measure of how well the NSRF investment programmes might boost welfare through raising the productivity and competitiveness of the economy. The overall picture is one of a gradually increasing level of productivity, measured relative to the “without-NSRF” baseline.<sup>50</sup> The very small negative adjustments in the years 2007, 2008 and 2009 are associated with the assumed big build-up of building and construction activity, where productivity appears to be declining slightly over the historical data sample period (1995-2004).

<sup>50</sup> It should be stressed that the level of productivity is already rising in the “no-NSRF” baseline (refer to Table 6.5.1 above). The NSRF increases the level of productivity even further.

Table 9.3.4:  
NSRF impacts on the level of economy-wide productivity

Date	LPROD (p)
2006	0.00
2007	-0.04
2008	-0.08
2009	-0.06
2010	0.11
2011	0.36
2012	0.52
2013	0.67
2014	0.87
2015	1.00
2016	1.22
2017	1.17
2018	1.17
2019	1.10
2020	1.04

#### 9.4 DETAILED DESCRIPTIONS OF THE NSRF IMPACTS: NOTATION

Using the without-NSRF baseline projection described in Section 6 above, we then set the NSRF public expenditures at the levels described in the official NSRF documents. The “without-NSRF” baseline is compared with the “with-NSRF” simulation, and any differences are as a measure of the NSRF impacts. These differences are usually expressed as percentage changes relative to the baseline, but can also be expressed as absolute differences from the baseline.

The detailed simulation results will be presented in the following section. In this section, we present an explanation of the variable short-hand notation. Clearly there is a large amount of information contained in the tables in the next section, and great care has to be exercised to ensure that the tables are interpreted correctly and accurately.

As explained in the previous section, the following notation is used:

- i. Where (p) is shown beside the variable name, this means that the results are percentage changes relative to the without-NSRF baseline;

- ii. Where (g) is shown beside a variable name, this indicates that a simple annual growth rate is shown (i.e., growth in the variable over time, and NOT relative to any baseline);
- iii. Where (l) is shown beside a variable name, this indicates a level of the variable in the “with NSRF” simulation;
- iv. Where (d) is shown beside a variable name, this indicates a difference relative to the baseline. For example, “L(d)” indicates that this is the change in numbers employed (expressed in thousands) in the “with” simulation relative to the “without” simulation.

In Table 9.5.1, the first two variables ( **GDPM0(g)** and **L0(g)** ) show the annual growth rate of GDP and growth rate of total employment in the baseline (without-NSRF) simulation. The third variable (**UR0(l)**) shows the level of the unemployment rate in the baseline. These were described in Section 6 above, but are repeated here in order to give some perspective to the size of the subsequent NSRF impacts.

In Table 9.5.2, the next two variables show the EC finance (**GECSFRAE(l)**), as well as the “EC plus domestic public co-finance” (**GECSFRAP(l)**), both of which are expressed as a percentage of GDP. It should be noted that the values of GECSFRAE (the EC part) are not the same as the rates implicit in ex-ante guidelines of the European Commission. This is because the HERMIN-generated baseline projections are used to calculate the above two ratios. In the Commission guidelines, a base-year value of GDP is used, which is, of course, lower than the values for subsequent years when the economy is growing strongly.

In Table 9.5.3, the next three variables give an indication of the percentage increase in the stocks of physical infrastructure (**KGINFR(p)**), human capital (**KTRNR(p)**) and R&D (**KRTRIRD(p)**) caused by the NSRF policy shock. Since the bulk of the funding is spent on physical infrastructure (on average, about 70 per cent), the increase is correspondingly greater than for human capital.<sup>51</sup>

In Table 9.5.4, the next seven variables provide measures of the impact of the policy shock on the aggregate economy:

- i. **GDPM(g)** shows the growth rate in GDP in the case of the with-NSRF shock
- ii. **GDPM0(g)** shows the growth rate in GDP in the case of the without-NSRF shock. It should be emphasised again that the difference between GDPM(g) and GDPM0(g) will give the impact of the NSRF on the growth rate of GDP.
- iii. **GDPM (p)** shows the percentage rise in the level of GDP relative to the “no-shock” baseline. It should be stressed that the HERMIN methodology analyses the shift in the level of GDP caused by the NSRF shock. Thus, there can be (and usually is) a semi-permanent rise in the level of GDP as a result of the NSRF programmes. But the growth rate of GDP is only boosted temporarily (as the economy adjusts from the

---

<sup>51</sup> We stress that the KGINFR, KTRNR and KRTRIRD measures are constructed in a way that makes them only broad indicators of the underlying reality. For details of the approach, see Bradley, Petrakis and Traistaru, 2004.

lower to the higher level), and there is no long-term rise in the growth rate. This can be seen by examination of  $GDPM(g)$  and  $GDPM0(g)$  above.<sup>52</sup>

- iv. **L(p)** shows the percentage rise in the level of total employment relative to the “no-shock” baseline;
- v. **L(d)** shows the absolute change in the level of total employment relative to the “no-shock” baseline (all employment is measured in thousands);
- vi. **UR(d)** shows the change in the unemployment rate relative to the “no-shock” baseline.
- vii. **LPROD(p)** shows the percentage rise in the level of aggregate productivity relative to the “no-shock” baseline.

In Table 9.5.5, the next set of four variables repeats some of the previous aggregate measures, but applied specifically to the manufacturing sector:

- i. **OT(p)** shows the percentage rise in the level of GDP in manufacturing relative to the “no-shock” baseline;
- ii. **LT(p)** shows the percentage rise in the level of employment in manufacturing relative to the “no-shock” baseline;
- iii. **LT(d)** shows the absolute rise in the level of employment in manufacturing relative to the “no-shock” baseline (all employment is measured in thousands);
- iv. **LPRT(p)** shows the percentage rise in the level of productivity in manufacturing relative to the “no-shock” baseline.

In Table 9.5.6, the next set of four variables repeats the previous manufacturing measures, but now applied specifically to the building and construction sector. Activity in this sector is boosted greatly during the implementation phases of the NSRF programmes of investment in physical infrastructure, but tends to fall back very quickly after the programmes are assumed to be cut off abruptly at the end of the year 2015.

- i. **OBC(p)** shows the percentage rise in the level of GDP in market services relative to the “no-shock” baseline;
- ii. **LBC(p)** shows the percentage rise in the level of employment in market services relative to the “no-shock” baseline;
- iii. **LBC(d)** shows the absolute rise in the level of employment in market services relative to the “no-shock” baseline (all employment is measured in thousands);

---

<sup>52</sup> The “level” versus “growth rate” impacts of physical infrastructure, human capital and R&D shocks remains unresolved in the international research literature. The adoption of the “levels” approach in the HERMIN-based evaluations is the conservative one.

- iv. **LPRBC(p)** shows the percentage rise in the level of productivity in market services relative to the “no-shock” baseline.

In Table 9.5.7, the next set of four variables repeats the same measures, but now applied specifically to the market services sector.

- v. **OMS(p)** shows the percentage rise in the level of GDP in market services relative to the “no-shock” baseline;
- vi. **LMS(p)** shows the percentage rise in the level of employment in market services relative to the “no-shock” baseline;
- vii. **LMS(d)** shows the absolute rise in the level of employment in market services relative to the “no-shock” baseline (all employment is measured in thousands);
- viii. **LPRMS(p)** shows the percentage rise in the level of productivity in market services relative to the “no-shock” baseline.

In Table 9.5.8, the next two variables measure the impact of the policy shock on the two major expenditure aggregates: household consumption and total investment:

- i. **CONS(p)** shows the percentage rise in the level of household consumption relative to the “no-shock” baseline;
- ii. **I(p)** shows the percentage rise in the level of total fixed investment relative to the “no-shock” baseline;

In Table 9.5.9, the next seven variables examine the impacts of the policy shock on prices and wages;

- i. **PGDPFC(p)** shows the percentage rise in the level of the deflator of aggregate GDP relative to the “no-shock” baseline;
- ii. **POT(p)** shows the percentage rise in the level of the deflator of manufacturing GDP relative to the “no-shock” baseline;
- iii. **POMS(p)** shows the percentage rise in the level of the deflator of market services GDP relative to the “no-shock” baseline;
- iv. **PCONS(p)** shows the percentage rise in the level of the deflator of household consumption relative to the “no-shock” baseline;

- v. **WT(p)** shows the percentage rise in the level of average earnings in manufacturing relative to the “no-shock” baseline;
- vi. **WT(g)** shows the inflation rate of manufacturing wages rates in the case of the “with-NSRF” simulation.
- vii. **WT0(g)** shows the inflation rate of manufacturing wages rates in the case of the “with-out-NSRF” simulation.

In Table 9.5.10, the final two variables give the impact of the policy shock on the trade and the public sector balances:

- i. **NTSVR(d)** shows the absolute change in the net trade surplus, expressed as a percentage of GDP, relative to the no-shock baseline;
- ii. **GBORR(d)** shows the absolute change in the public sector borrowing requirement, expressed as a percentage of GDP, relative to the no-shock baseline.

## 9.5 DETAILED DESCRIPTIONS OF THE NSRF IMPACTS: RESULTS

Table 9.5.1 repeats some aggregate data from the “without-NSRF” baseline scenario. The “without-NSRF” scenario is one of steady growth (of over 4 per cent); a small positive growth in total employment; and a slowly declining rate of unemployment.

Table 9.5.1:  
The without-NSRF baseline projection

Date	GDPM (g)	L (g)	UR (l)
2006			7.44
2007	4.28	0.76	7.20
2008	4.11	0.57	7.13
2009	4.21	0.67	6.97
2010	4.18	0.64	6.84
2011	4.22	0.68	6.67
2012	4.23	0.68	6.51
2013	4.25	0.69	6.33
2014	4.25	0.70	6.14
2015	4.26	0.71	5.94
2016	4.27	0.72	5.73
2017	4.28	0.73	5.51
2018	4.28	0.74	5.29
2019	4.29	0.75	5.06
2020	4.29	0.75	4.82

Table 9.5.2 shows the EC funding and the total public funding (EC plus domestic public), expressed as a percentage of the ex-post (or with-NSRF) level of GDP. The assumed rate of domestic public co-finance was 15%. Due to differences in the processes of indexation used in the model, the ex-post co-finance rate implicit in Table 9.5.2 will be slightly different.

What Table 9.5.2 illustrates is that the shock to the Czech economy is largest in the initial year, 2007. Due to the strong underlying growth of the Czech economy over the period 2007-2015, the size of the NSRF shock declines, when expressed as a share of ex-post GDP.

Table 9.5.2:  
The NSRF expenditures relative to ex-post GDP

Date	GECSFRAE (I)	GECSFRAP (I)
2006	0.00	0.00
2007	0.30	0.36
2008	0.96	1.13
2009	1.61	1.89
2010	1.68	1.97
2011	1.82	2.14
2012	1.85	2.17
2013	2.02	2.37
2014	1.55	1.83
2015	1.50	1.77
2016	0.00	0.00
2017	0.00	0.00
2018	0.00	0.00
2019	0.00	0.00
2020	0.00	0.00



Table 9.5.3 illustrates how the three “stocks” associated with the NSRF increase over time.

Table 9.5.3:  
The NSRF-induced increases in stocks of infrastructure, human capital and R&D

Date	KGINFR (p)	KTRNR (p)	KRTRIRD (p)
2006	0.00	0.00	0.00
2007	3.44	0.79	2.84
2008	6.26	1.48	5.28
2009	8.73	2.11	7.44
2010	10.93	2.67	9.35
2011	12.92	3.18	11.07
2012	14.73	3.64	12.61
2013	16.39	4.05	13.99
2014	14.68	3.83	12.74
2015	13.28	3.62	11.61
2016	12.07	3.42	10.59
2017	11.01	3.23	9.66
2018	10.06	3.06	8.82
2019	9.20	2.89	8.06
2020	8.42	2.73	7.37

The relatively small scale of the ESF schemes (as a share of the NSRF) show up as a modest rise in the stock of human capital (KTRNR). However, the increases in the stocks of physical infrastructure and R&D are broadly similar, even though the NSRF expenditures on physical infrastructure are much larger than expenditures on R&D.<sup>53</sup>

In Table 9.5.4, we present the impacts of the NSRF on the main macroeconomic aggregates (GDP, employment, unemployment and productivity). Most of these have been discussed in Section 6 above. However, it should be noted that the cut in the unemployment rate during the nine years of NSRF implementation (after invoking the so-called “n+2” rule to extend the activities over the period 2007-2015), by between 3 and 4 percentage points, is much smaller after the NSRF is terminated at the end of 2015. This is due to a combination of the demand effects of withdrawing the NSRF funding, as well as the higher level of labour pro-

<sup>53</sup> The NSRF-induced changes in stocks of physical infrastructure, human capital and R&D are influenced by the initial size of the stock. This initial stock level is not easy to define, and will be the subject of continuing investigation and improvement.

ductivity in the post-NSRF period. If there were continuation NSRF-type programmes after 2015, then the cut in unemployment would endure.

Table 9.5.4:  
NSRF: impacts on macro aggregates

Date	GDPM (g)	GDPM0 (g)	GDPM (p)	L (p)	L (d)	UR (d)	LPROD (p)
2006			0.00	0.00	0.00	0.00	0.00
2007	4.68	4.28	0.38	0.40	19.66	-0.37	-0.04
2008	5.00	4.11	1.24	1.26	62.85	-1.17	-0.08
2009	5.29	4.21	2.29	2.22	111.57	-2.06	-0.06
2010	4.75	4.18	2.84	2.57	130.05	-2.39	0.11
2011	5.08	4.22	3.69	3.13	159.31	-2.92	0.36
2012	4.61	4.23	4.07	3.33	170.80	-3.11	0.52
2013	4.90	4.25	4.72	3.80	196.28	-3.56	0.67
2014	3.88	4.25	4.35	3.25	169.03	-3.05	0.87
2015	4.54	4.26	4.62	3.39	177.81	-3.19	1.00
2016	2.03	4.27	2.37	1.06	55.91	-1.00	1.22
2017	4.34	4.28	2.44	1.20	63.62	-1.13	1.17
2018	3.68	4.28	1.84	0.64	34.33	-0.61	1.17
2019	4.25	4.29	1.81	0.68	36.72	-0.65	1.10
2020	4.07	4.29	1.59	0.53	28.61	-0.50	1.04

In the next set of three Tables we present sectoral analysis of the NSRF impacts. Table 9.5.5 examines the impacts on manufacturing. This sector is the main beneficiary of the positive spillover mechanisms associated with the NSRF. Hence, the increase in the level of output (OT) relative to the without-NSRF baseline, rises to 6.1 per cent by the year 2015. Even by the year 2020, the NSRF-induced increase in the level of output is still about 3.3 per cent. The employment creation and productivity-enhancing impacts are also high, and also endure after the termination of the NSRF.

Table 9.5.5:  
NSRF: impacts on manufacturing

Date	OT (p)	LT (p)	LT (d)	LPRT (p)
2006	0.00	0.00	0.00	0.00
2007	0.36	0.36	4.71	0.00
2008	1.15	1.07	14.08	0.08
2009	2.15	1.81	23.88	0.33
2010	2.82	2.07	27.22	0.74
2011	4.11	2.83	37.31	1.25
2012	4.70	3.07	40.53	1.59
2013	5.65	3.65	48.31	1.93
2014	5.47	3.22	42.67	2.18
2015	6.10	3.66	48.47	2.35
2016	3.85	1.59	21.09	2.23
2017	4.30	2.30	30.49	1.96
2018	3.77	1.94	25.72	1.80
2019	3.67	2.00	26.54	1.64
2020	3.33	1.80	23.84	1.51

Unlike manufacturing, the NSRF impacts on building and construction only endure for the implementation period 2007-2015. This is the sector that actually produces physical infrastructure. The increase in the level of output (relative to the without-NSRF baseline), peaks at 14.7 per cent in the year 2015. Thereafter, there is only a very small enduring increases, which is 1.3 per cent by 2020. The employment pattern behaves in much the same way, with almost no enduring net employment gains after 2016. Unlike manufacturing, the NSRF does not induce any productivity gains in this sector.

Table 9.5.6:  
NSRF: impacts on building and construction

Date	OBC (p)	LBC (p)	LBC (d)	LPRBC (p)
2006	0.00	0.00	0.00	0.00
2007	1.48	1.58	6.77	-0.10
2008	4.91	5.24	22.41	-0.32
2009	9.00	9.61	41.00	-0.56
2010	10.83	11.57	49.15	-0.66
2011	13.09	13.98	59.25	-0.78
2012	14.26	15.23	64.40	-0.84
2013	16.34	17.45	73.66	-0.95
2014	14.34	15.31	64.52	-0.84
2015	14.70	15.70	66.06	-0.86
2016	4.89	5.20	21.87	-0.30
2017	4.26	4.54	19.07	-0.27
2018	1.93	2.04	8.58	-0.11
2019	1.88	2.00	8.39	-0.11
2020	1.31	1.39	5.84	-0.08

The third sector examined in market services (MS), and the results are shown in Table 9.5.7. The output gains here are relatively modest (compared, say, to manufacturing), and arise from the demand-side impacts of the stimulus to the manufacturing, building and construction, and government sectors. There are, of course, some NSRF measures that are targeted directly at this sector (e.g., tourism, business services), but these are modest compared to the main NSRF expenditure programmes in physical infrastructure<sup>54</sup>

<sup>54</sup> It should be emphasised that we are carrying out a macroeconomic impact evaluation of the NSRF. If it were desired to explore the specific detailed impacts on certain service sector activities, a more detailed micro-economic evaluation would be required (see Bradley, Mitze, Morgenroth and Untiedt, 2006 for details).

Table 9.5.7:  
NSRF: impacts on market services

Date	OMS (p)	LMS (p)	LMS (d)	LPRMS (p)
2006	0.00	0.00	0.00	0.00
2007	0.35	0.34	7.40	0.01
2008	1.15	1.07	23.87	0.07
2009	2.12	1.88	42.49	0.24
2010	2.62	2.14	49.23	0.47
2011	3.25	2.48	57.83	0.76
2012	3.53	2.56	60.84	0.95
2013	4.02	2.85	68.74	1.14
2014	3.63	2.34	57.51	1.26
2015	3.75	2.37	59.02	1.36
2016	1.75	0.51	12.95	1.23
2017	1.64	0.55	14.06	1.09
2018	1.00	0.00	0.02	0.99
2019	0.98	0.07	1.79	0.91
2020	0.80	-0.04	-1.07	0.84

In Table 9.5.8 we present the NSRF impacts on the two aggregate expenditure categories: private consumption (CONS) and total investment (I). Although these impacts are important, they are not at the centre of the main chains of policy influence for the programmes of investment contained within the NSRF. The impacts on consumption arise from the demand-side spillovers from the mainly supply-side boost to the economy brought about by the NSRF. The peak boost is in the year 2013, when the level of “with-NSRF” consumption is almost 6.3 per cent higher than the “without-NSRF” level of consumption.

The increases in the levels of total investment are much higher, since the NSRF is implemented on the supply-side of the economy mainly through public investment programmes, and induced private sector investment. The peak boost is in the year 2013, when the level of “with-NSRF” total investment is nearly 15 per cent higher than the “without-NSRF” level of total investment. After 2015, the impact declines rapidly.

Table 9.5.8:  
**NSRF: impacts on expenditure aggregates**

Date	CONS (p)	I (p)
2006	0.00	0.00
2007	0.52	1.55
2008	1.75	5.13
2009	3.23	9.15
2010	4.00	10.44
2011	5.04	12.17
2012	5.50	12.97
2013	6.27	14.65
2014	5.71	12.35
2015	5.91	12.38
2016	2.93	3.05
2017	2.78	2.54
2018	2.06	1.72
2019	1.99	1.64
2020	1.75	1.39

In Table 9.5.9 we examine the impacts of the NSRF on the levels of wages and prices, and on inflation rates. These two issues (price level effects and price inflation effects) should not be confused.

To illustrate this, the final two columns in Table 9.5.9 show the “with-NSRF” rate of wage inflation in manufacturing (WT(g)) and the “without-NSRF” rate of wage inflation (WT0(g)). The more gradual phasing of the manner in which the Czech NSRF is implemented from 2007 – compared to the previous “abrupt” start-up), and terminated after 2015 has some inflationary consequences. The rate of wage inflation in the “without-NSRF” baseline is already fairly high, since it is sustained by a big increase in the level of productivity (see Table 6.5.1 above). In the NSRF implementation year (2007), this rate of wage inflation rises slightly to 7.2 per cent per year (an increase in 0.3 percentage points from its base level of 6.9 percent per year). During the years 2008-2013, there is an inflationary “gap” of between 1 and 2 percentage points. After 2015 this process is reversed, as the abrupt termination of the NSRF from a high peak after 2015 drives down wage inflation. After 2018, the rate of wage inflation for the “with-NSRF” and “without-NSRF” are broadly similar.

Turning to the third last column of Table 9.5.9, we show the impacts of the NSRF of the level of manufacturing wages relative to the “without-NSRF” baseline. By the year 2013, the level of wages in the “with-NSRF” case is 11.6 per cent higher than the level in the “without-

NSRF” case. After that, the impact declines, and by the year 2020 the increase in the level of wages is only 2.7 per cent higher than in the “without-NSRF” baseline scenario.

This result should serve to emphasise the point that an abrupt implementation of the Czech NSRF would be very likely to have serious inflationary consequences, as the economy overheats. Similarly, the abrupt termination of the NSRF in the year 2013 will have serious deflationary consequences. These effects are more modest when the NSRF is phased in and phased out more gradually.<sup>55</sup>

Table 9.5.9:  
NSRF: impacts on price levels and inflation

Date	PGDPFC (p)	POT (p)	POMS (p)	PCONS (p)	WT (p)	WT (g)	WT0 (g)
2006	0.00	0.00	0.00	0.00	0.00		
2007	0.34	0.16	0.38	0.32	0.52	7.42	6.86
2008	1.52	0.65	1.74	1.42	2.27	8.93	7.07
2009	3.44	1.37	4.04	3.20	4.97	9.76	6.94
2010	5.10	1.86	6.12	4.74	7.13	9.24	7.04
2011	6.30	2.19	7.65	5.85	8.84	8.75	7.04
2012	7.28	2.48	8.88	6.76	10.23	8.45	7.09
2013	8.15	2.73	9.97	7.55	11.51	8.37	7.12
2014	8.27	2.68	10.22	7.66	11.60	7.25	7.16
2015	7.90	2.51	9.81	7.31	11.15	6.76	7.19
2016	5.71	1.62	7.36	5.29	7.85	4.03	7.22
2017	3.15	0.75	4.23	2.92	4.53	3.94	7.24
2018	2.17	0.59	2.96	2.01	3.82	6.55	7.27
2019	1.60	0.40	2.26	1.48	2.99	6.43	7.29
2020	1.35	0.36	1.94	1.25	2.75	7.06	7.32

<sup>55</sup> The external “anchor” to Czech manufacturing prices only operates if the exchange rate is fixed. If the exchange rate were not fixed, then Czech manufacturing price changes, denominated in koruna could deviate from world prices, denominated in (say) euro.

Our final table shows the NSRF consequences for the public sector borrowing requirement (GBORR), the national debt (RDEBT) and the net trade balance (NTSVR). All three variables are defined as a percentage of GDP.

The interpretation of these impacts is as follows. During the NSRF implementation (2007-2013), there is a deterioration in the trade balance, by between 1 and 2 per cent of GDP. This is what one would expect from the demand-side implementation phase of the NSRF, between the years 2007 and 2015. There is also an increase in the borrowing requirement (of up to 1 per cent of GDP), with a knock-on deterioration in the national debt over time, ending up being higher by about 7 per cent of GDP). After the termination of the NSRF (in 2015), the trade and borrowing impacts vanish, but the increase in the debt stock endures.

Table 9.5.10:  
NSRF: impacts on public and private macro balances

Date	NTSVR (d)	GBORR (d)	RDEBT (d)
2006	0.00	0.00	0.00
2007	-0.33	0.22	0.06
2008	-1.06	0.70	0.26
2009	-1.77	1.14	0.65
2010	-1.82	1.13	1.22
2011	-1.88	1.12	1.77
2012	-1.87	1.07	2.45
2013	-1.98	1.13	3.05
2014	-1.45	0.80	3.93
2015	-1.31	0.74	4.60
2016	0.24	-0.19	6.15
2017	0.35	-0.13	6.77
2018	0.20	0.06	7.10
2019	0.21	0.13	7.00
2020	0.15	0.16	6.87



## 9.6 CONCLUSIONS ON NSRF IMPACTS

The response of the Czech economy during the “seven + two” “implementational” years (2007-2015) is made up of two separate elements:

- iii. A demand-side (or Keynesian) part, which is determined by the size of the Keynesian demand-side multiplier implicit in the Czech HERMIN model. As shown in Section 6 above, these Keynesian multipliers are likely to be rather small in the case of the very open Czech economy;

and

- iv. A pure supply-side impact that arise due to the gradual build-up of stocks of infrastructure, human capital and R&D. These effects endure even after the implementation phase is over.

The complexity of analysing the impacts of the NSRF arises from the inter-mingling of these two separate processes. In the real world, they cannot be distinguished. Only with a macro-sectoral model like HERMIN or QUEST is it possible to identify and quantify the separate chains of causation. For example, if one confined the NSRF impact analysis to the period 2007-2015 (i.e., the implementational period), the two separate effects would be very difficult to disentangle. During the implementational period, the demand-side effects tend to dominate. In order to identify the separate supply-side impacts, we have to simulate the model out beyond the year 2015. In the tables above, we terminate the simulations in the year 2020, i.e., five years after the termination of the NSRF. What the tables show is that although the implementational impacts are large, they vanish almost completely after the year 2015. The supply-side impacts, although more modest, endure for many years, due to the spillover benefits of the improved stocks of physical infrastructure, human capital and R&D.

---

## FUTURE DEVELOPMENTS IN THE CZECH NSRF EVALUATION

It is important to emphasise that in this report we are focused completely on the NSRF impacts. A separate study would be needed to estimate the likely impacts of the NSRF in conjunction with other issues such as the Single market, enhanced inward foreign direct investment (FDI), etc. For details of such a study in the case of Greece, Ireland, Portugal and Spain, see the contribution of Bradley et al, 1997, to the ex-post evaluation of Structural Funds and the Single Market in the Commission study led by Commissioner Mario Monti.

We also emphasise that the agriculture sector in HERMIN is fairly static, and tends to function almost independently of the rest of the economy. With no rural aid schemes, it is almost untouched by the NSRF policy shock. Activity in the government sector is related to NSRF policy instruments, and is involved to a modest extent in the delivery of NSRF-related human resource ESF training programmes.

It is also well known that growth in market service sector activities is likely to be strong in the Czech Republic as well as in the rest of the CEE region. But our simulations are only looking at the specific impacts of an NSRF policy shock, and abstract from these other background changes.

Finally, future work on the evaluation of the Czech NSRF will need to focus on three areas of research:

- i. First, the Czech HERMIN model is constantly being updated and improved, as new data and research becomes available;
- ii. Second, in preparing the Czech NSRF for analysis using HERMIN, we were obliged to make a series of simplifying assumptions about the nature of the NSRF programmes. For example, it was not always clear how to classify the funding allocations into physical infrastructure (PI), human resources (HR) and aid to producers (APS). Within each of these categories, there was a further possible classification: PI into productive and social infrastructure; HR into economic and social aspects; APS into R&D and other supports to producers.
- iii. Third, it was very difficult to assign the appropriate values of the “spillover” elasticities, in the absence of details about the various NSRF measures, and in the absence of any micro-economic evaluations. This is an area of research that needs to become active, if future evaluations of the NSRF are to be carried out with precision.

## REFERENCES

- Adams, P. D., Dixon, P. B. 1997. "Generating detailed commodity forecasts from a computable general equilibrium model", *International Journal of Forecasting*, 13, 223-236.
- Aghion, P., Blanchard, O. 1994. "On the speed of transition in Central Europe", *NBER Macroeconomics Annual*, 283-320.
- Arlt, J., Cutkova, J., Radkovsky, S. 2002. "Nektere aspekty spotrebni funkce v podminkach Ceske republiky 90. let." *Politicka Ekonomie*, 50(1), 3-23.
- Aschauer, D. 1989. "Is Public Expenditure Productive?", *Journal of Monetary Economics*, Vol. 3, 177-200.
- Bajo-Rubio, O., Sosvilla-Rivero, S. 1993. "Does public capital affect private sector performance? An analysis of the Spanish case, 1964-1988", *Economic Modelling*, 10(3), 179-185.
- Balard, C., Fullerton, D., Shoven, J., Whalley, J. 1985. *A General Equilibrium Model for Tax Policy Evaluation*, University of Chicago Press.
- Banse, M., Guba, W., Münch, W. 1998. *Domestic Resource Costs based on CGE Simulations: Results for the Food Industries of Hungary and Poland*, presented at: the joint workshop of ESA-FAO and the Institute of Agricultural Development in Central and Eastern Europe (IAMO), Halle, Germany.
- Barrel, R., Holland, D., Pain, N., Kovacs, M.A., Jakab, Z., Smidkova, K., Sepp, U., Cufer U. 2004. "An Econometric Macro-model of Transition: Policy Choices in the Pre-Accession Period". *Royal Economic Annual Conference 15*, Royal Economic Society
- Barrell, R., Holland, D. 2002. "The NIGEM approach to modelling EU accession", paper presented at *Macromodels 2002*, Cedzyna, The Czech Republic, December 4-7.
- Barry, F., Bradley, J. 1999. *The comparative study of transition and cohesion*. Research project supported under ACE-Phare Research Contract number P96-6242-R
- Barry, F., Bradley, J. 1999. "Comparative study of transition and cohesion", Working Paper submitted to the Commission of the EU under the project P96-242R: *Macroeconomics and structural change: common themes between CEE and EU periphery countries*.
- Barry, F., Bradley, J., Hannan, A., McCartan, J., Sosvilla-Rivero, S. 1997. *Single Market Review 1996: Aggregate and regional impact: the cases of Greece, Spain, Ireland and Portugal*, Office for Official Publications of the European Communities in association with Kogan Page, London. (168 pages).
- Barry, F., Bradley, J., Kejak, M., Vavra, D. 2003. "The Czech economic transition: exploring options using a macrosectoral model", *The Economics of Transition*, 11(3), 539-67.
- Bassanini, A., Rasmussen, J. H., Scarpetta, S. 1999. "The economic effects of employment-conditional income support schemes for the low-paid: an illustration from a CGE model applied to four OECD countries", *OECD working paper* No. 224.
- Benes, J., Vavra, D. 2005. "Eigenvalue filtering in VAR models with application to the Czech business cycle". *Working Paper Series*, 549, European Central Bank.

- Benes, J., Hledik, T., Kumhof, M., Vavra, D. 2005. "An Economy in Transition and DSGE: What the Czech National Bank's New Projection Model Needs". *CNB Working Paper*, 12.
- Benes, J., Hledik, T., Vavra, D. 2003a. *Developing a New Generation of Core Models for the FSAP of the CNB*. First-year research report, CNB, mimeo.
- Benes, J., Hledik, T., Vavra, D., Vlcek, J. 2003b. "The Quarterly Projection Model and its Properties", in Coats, W., Laxton, D., Rose, D. (eds), *The Czech National Bank's Forecasting and Policy Analysis System*. Prague, CNB.
- Benes, J., Vavra, D., Vlcek, J. 2002. "[Strednedoba makroekonomicka predikce makroekonomicke modely v analytickem systemu CNB](#)", *Finance a uver*, 4, 197-231.
- Berndt, E. 1991. "Modelling the simultaneous demand for factors of production", in Hornstaein, Z., Grice, J., Webb, A. (eds.), *The Economics of the Labour Market*, HMSO, London.
- Bezdek, V., Stiller, V. 2000. "[Modelovani hlavnich danovych prijmu ceske rozpocetove soustavy](#)". *Finance a uver*, 2, 66-77.
- Bezdek, V. et al. 2005. *Závěrečná zpráva - Důchodová reforma : možnosti a výhledy* [Final report - Pension system reform : options and outlooks]. 1. vyd. Praha : Úřad vlády ČR.
- Blanchard, O. 1997. *The Economics of Post-Communist Transition*. Oxford University Press, Oxford.
- Blanchard, O., Fischer, S. 1990. *Lectures in Macroeconomics*, Cambridge, Massachusetts: The MIT Press.
- Boeri, T., Burda, M. 1997. "Aktivni politika na trhu prace, sladeni nabidky s poptavkou a tzv. cesky zazrak". *Politicka Ekonomie*, 2, 183-192.
- Bradley, J., Whelan, K. 1995. "HERMIN Ireland", *Economic Modelling* 12, special issue, 249-274.
- Bradley, J., Modesto, L., Sosvilla-Rivero, S. 1995. "HERMIN. A macroeconometric modelling framework for the EU periphery", *Economic Modelling* 12, special issue, 221-247.
- Bradley, J., O'Donnell, N., Sheridan, N., Whelan, K. 1995a. *Regional Aid and Convergence*, Aldershot (UK), Avebury
- Bradley, J., Herce, J.A., Modesto L. 1995b. "Modelling in the EU Periphery. The Hermin Project", *Economic Modelling* 12, special issue, 219-220.
- Bradley, J., Herce, J.A., Modesto, L. 1995c. "The macroeconomic effects of the CSF 1994-99 in the EU periphery. An analysis based on the HERMIN model", *Economic Modelling* 12, special issue, 323-334.
- Bradley, J., Modesto L., Sosvilla-Rivero, S. 1995d. "Similarity and diversity in the EU periphery. A HERMIN-based investigation", *Economic Modelling* 12, special issue, 313-322.
- Bradley, J., Modesto, L., Sosvilla-Rivero, S. 1995e: "HERMIN. A macroeconometric modelling framework for the EU periphery". *Economic Modelling* 12, special issue, 221-247.
- Bradley, J., Whelan, K. 1997. "The Irish expansionary fiscal contraction: A tale from open small European economy", *Economic Modelling* 14, 175-201.

- Bradley, J., Fitzgerald, J. 1988. "Industrial output and factor input determination in an econometric model of a small open economy", *European Economic Review* 32, 1227-1241.
- Bradley, J., Fitz Gerald, J. 1990. "Production Structures in a Small Open Economy with Mobile and Indigenous Investment", *European Economic Review*, 34, 364-374.
- Bradley, J., Fitz Gerald, J., Kearney, I. 1992. "The Role of the Structural Funds: Analysis of Consequences for Ireland in the Context of 1992", *Policy Research Series No. 13*, The Economic & Social Research Institute, Dublin.
- Bradley, J., Morgenroth, E., Untiedt, G. 2000. *HERMIN HGE4: A macro-sectoral model of East Germany – structure and properties*, report submitted to the Commission of the European Communities, DG REGIO, EFRE No. 98.02.17002, February.
- Bradley, J., Kangur, A., Kearney, I. 2001. "HERMIN HE4 – A medium-term macro-model of Estonia: structure, properties and forecasts", *Phare Working Paper*, Dublin: The Economic and Social Research Institute, February.
- Bradley, J., Kangur, A., Morgenroth, E. 2001. *Ex-ante analysis of the economic impact of the Estonian National Development Plan 2001-2004: An evaluation based on the HERMIN model*, Report prepared for the Ministry of Finance, Tallinn under PHARE Service Contract Number ES-9803.04.01.0012, September.
- Bradley, J., Morgenroth, E., Untiedt, G. 2002. *Analysis of the macroeconomic impact of the CSF on the economy of East Germany*, ifo dresden studien 30, Dresden: ifo Institut.
- Bradley, J., Petrakos, G., Traistaru, I. (eds.) 2004. *Integration, Growth and Cohesion in an Enlarged European Union*, New York: Springer.
- Bradley, J., Gacs, J., Kangur, A., Lubenets, N. 2004a "HERMIN: A macro model framework for the study of cohesion and transition", in J. Bradley, G. Petrakos and I. Traistaru (eds.), *Integration, Growth and Cohesion in an Enlarged European Union*, Springer, New York.
- Bradley, J., Kangur, A., Lubenets, N. 2004b "Macro impact evaluation of National Development Plans: Ireland and Estonia", in J. Bradley, G. Petrakos and I. Traistaru (eds.), *Integration, Growth and Cohesion in an Enlarged European Union*, Springer, New York.
- Bradley, J., Gács, J., Morgenroth, E., Untiedt, G. 2004c *A Study of the Macro-economic Impact of the Reform of EU Cohesion Policy*, Report submitted to the European Commission, Directorate-General for Regional Policy, Brussels. ([http://europa.eu.int/comm/regional\\_policy/sources/docgener/studies/pdf/3cr/macro\\_impact.pdf](http://europa.eu.int/comm/regional_policy/sources/docgener/studies/pdf/3cr/macro_impact.pdf) ).
- Bradley, J., Mitze, T., Morgenroth, E., Untiedt, G. 2005. "An Integrated Micro-Macro (IMM) approach to the evaluation of large-scale public investment programmes: The case of EU Structural Funds", *GEFRA Working Paper*, Muenster ([http://www.gefra-muenster.org/downloads/doc/IMM\\_05.pdf](http://www.gefra-muenster.org/downloads/doc/IMM_05.pdf)).
- Bradley, J., Pisa, V., Untiedt, G., Vavra, D. 2006. *HCZ5: A HERMIN five-sector macromodel of the Czech Republic: Description of database and model user manual*, GEFRA, April.
- Bradley, J., Mitze, T., Morgenroth, E., Untiedt, G. 2006. "How can we know if EU Cohesion Policy is successful? Integrating micro and macro approaches to the evaluation of Struc-

- tural Funds”, *GEFRA Working Paper*, Muenster, March. ([http://www.gefra-muenster.org/deutsch/publikationen/abstract.php?pub\\_id=96](http://www.gefra-muenster.org/deutsch/publikationen/abstract.php?pub_id=96))
- Bruha, J. 2001. *A green tax reform and unemployment: The case of The Czech Republic*.
- Bruha, J. 2001a. „Environmental Policy Impact on a Dynamic Investment Schedule“, *Prague Economic Papers*, 4, 365 – 372.
- Bruha, J. 2002. “Applied General Equilibrium Models2, *Politicka ekonomie*, 3, 407-417
- Bruha, J., Scasny, M. 2003. *Public finance aspects of green tax reform in the Czech Republic*, COM/ENV/EPOC/DAFFE/CFA(2003)126, OECD.
- Bryant, R., Zhang, L. 1994. *Alternative Specifications of Intertemporal Fiscal Policy in Macroeconomic Models: An Initial Working paper*. Mimeo, Brookings Institution, Washington.
- Bulir, A. 1994. „[Fiskalni politika v jednoduchem fiskalnim modelu](#)“, *Finance a uver*, 6, 293.
- Burda, M, Lubyova, L 1995. “The Impact of Active Labour Market Policies: A Closer Look at the Czech and Slovak Republics”, *CEPR, Discussion Paper*, 1102, February.
- Cadil, J. 2005. “Model of regional consumption expenditures multiplier”, *Politicka ekonomie*, 5.
- Carlin, W., Glynn, A., Van Reenen, J. 2001. “Export market performance of OECD countries: an empirical examination of the role of cost competitiveness”, *The Economic Journal*, vol. 111 (January), 128-162.
- Cihak, M. 1994. „[Jine pojeti makroekonomicke dynamiky?](#)“, *Finance a uver* 11, 634.
- Ciupagea, C., Manda, A. 1999. “The HERMIN macromodel of Romania”, *Working Paper 2, Ace-Phare project P96-6242-R*, March.
- Cizkowicz, P., Rzonca, A. 2005. „Non-Keynesian effects of fiscal contraction in new member states“, *Working Paper Series 519, European Central Bank*.
- Clarida, R., Gali, J., Gertler, M. 2000. “Monetary Policy Rules and Macroeconomic Stability: Evidence and Some Theory”, *The Quarterly Journal of Economics*, MIT Press, 115(1), 147-180, February.
- Congressional Budget Office (2005). *R&D and Productivity Growth*, Congressional Budget Office, The Congress of the United States, June.
- Cooley, T.F. 1997. “Calibrated models”, *Oxford Review of Economic Policy*, 13, 55-69.
- D’Alcantara, G., Italianer, A. 1982. *A European project for a multinational macrosectoral model*, Document MS 11, DG XII, Brussels: Commission of the European Communities.
- Denny, K., Harmon, C., O’Connell, P. 2000. “Investing in People: The Labour Market Impact of Human Resource Interventions Funded Under The 1994-1999 Community Support Framework in Ireland”, *Policy Research Series No. 38*, Dublin: The Economic and Social Research Institute, November.
- Dervis, K., Melo, J., Robinson, S. 1991. *General equilibrium models for development policy*. Cambridge University Press, Cambridge.

- Dlouhy, V. 1986. "On the Problem of Macroeconomic Modelling in Centrally Planned Economies", *Ekonomicko-matematicky obzor*, no. 22.
- DybcaK, K., de Haan, H., 2005. *A computable general equilibrium model of the Czech economy 2000-2010*, Ministry of Finance of the Czech Republic & SEOR Rotterdam, mimeo.
- ESRI. 1997. *Single Market Review 1996: Aggregate and Regional Impacts: The Cases of Greece, Ireland, Portugal and Spain*. Kogan Page, London in association with the Commission of the European Communities.
- Fidmuc, J., Fidmuc, J. 2000. "Macroeconomic Development in the Czech Republic and Accession to the European Union", *Prague Economic Papers*, 4.
- Fidmuc, J., Fidmuc, J. 2000. *Macroeconomic Developments in the Czech Republic and the EU Accession Process*, Interim Report of IR-00-008, IIASA.
- Filacek, J. 2002. „Model spotreby domacnosti v letech 1994-1998“. *Finance a Uver*, 49(7), 427-37.
- Fischer, J. 2004. "Quarterly Estimates of Expenditures on Gross Domestic Product and Their Stability", *Politicka ekonomie*, 3.
- Fischer, S., Sahay, R. Végh, C. 1998. „From transition to market: Evidence and growth prospects“, *IMF Working Paper*, April.
- Flek, V. 2001. "Vykonnost a struktura nabidkove strany", *Politicka ekonomie*, 49(6), 771-796
- Frait, J., Komarek, L. 2002. „[Ceska ekonomika v makroekonomickych modelech](#)“, *Finance a uver*, 2, 190-196.
- Gingsburg, V., Keyzer, M. 1997. *The structure of applied general equilibrium models*. MIT Press, Cambridge, Massachusetts.
- Gottvald, J. 2003. "Determinants of Individual Wages in the Czech Republic and Slovak Republic Firms", *Politicka ekonomie*, 4, 541-564.
- Hajek, M. 1998. "Macroeconomic Analysis of the Czech Economy in 1997- Chosen Problems", *Politicka ekonomie*, 2, 177-222.
- Hajek, M., Bezdek, V. 2001. „Odhad potencialniho produktu a produkcní mezery v Ceske republice“, *Politicka-ekonomie*, 49(4), 473-491.
- Hanousek, J., Tuma, Z. 1994. „[Makroekonomicky model ceske ekonomiky: navrh mozneho pristupu](#)“, *Finance a uver* 1. 18.
- Hanousek, J., Tuma, Z. 1995b. "Money Demand in the Czech Economy", *Finance a Uver*, 5, 249-268.
- Hanousek, J., Kubin, J., Tuma, Z. 1995a. "Money Demand and Seigniorage in Transition Period", *Finance a Uver*, 7, 352-368.
- Harris, J., Todaro, M. 1970. "Migration, Unemployment and Development: A Two Sector Analysis", *American Economic Review*, Vol. 60, 126-142.
- Harrison, G.W., Rutherford, T.F., Tarr, D.G. 1997 "Economic implications for Turkey of a Customs Union with the European Union". *European Economic Review*, 41 ,861-870, April.

- Harrison, G. W., Rutherford, T. F., Tarr, D. 1997. "Opciones de política comercial para Chile: una evaluación cuantitativa", *Cuadernos de Economía*, 101-137.
- Havlicek, L. 1996. "Makroekonomický model MMM1", *Finance a uver*, 11, 652.
- Holub, T. 1996. "Analysis of Import Demand in the Czech Republic", *Finance a Uver*, 9, pp. 511 – 519.
- Holub, T. 1997a. "Analysis of Import Demand in the Czech Republic", *Prague Economic Papers*, 3, 268-276.
- Holub, T. 1997b. "Money Multiplier and Monetary Development in the Czech Republic", *Finance a Uver*, 3, 129-142.
- Honohan, P. (1997). "EU Structural Funds in Ireland: A Mid-Term Evaluation of the CSF 1994-1999", *Policy Research Series* No. 31, Dublin: The Economic and Social Research Institute.
- Hrebíček, H. 2006. *Bayesian estimation of the Czech National Bank's Quarterly Projection Model*, Czech National Bank, mimeo.
- Hrebíček, H., Vlček, J. 2006. *Non-linear Phillips Curve: the Nairu in the Czech Republic*, Czech National Bank, mimeo.
- Hsing, Y. 2004. "Impacts of Macroeconomic Policies on Output in the Czech Republic: An Application of Romer's IS-MP-IA Model", *Prague Economic Papers*, December.
- Hurník, J. 2004. "Fiscal Consolidation in General Equilibrium Framework (The Case of the Czech Republic)", *Prague Economic Papers*, 2, 142-158.
- Hurník, J., Navrátil, D. 2004. "Labour Market Performance and Macroeconomic Policy: The Time-Varying NAIRU in the Czech Republic", in Flek (ed.), *Anatomy of the Czech Labour Market: From Over-Employment to Under-Employment in Ten Years?* Working Paper, 7, CNB.
- Hurník, J., Navrátil, D. 2005. "Potential Output in the Czech Republic: A Production Function Approach". *Prague Economic Papers*. September; 14(3), 253-66.
- Husek, R. 1996. "Econometric Analysis of the CR Consumption Function". *Prague Economic Papers*, no. 1.
- Husek, R. 2000. "Econometric Analysis of Production Functions", *Politická ekonomie*, 1, 97-112.
- Izak, V. 1996. „Inflation, Wages and Money” *Prague Economic Papers*, 3, 195-206.
- Izak, V. 2000. „Ceska dezinflace a hruby domaci produkt” (Czech Disinflation and Gross Domestic Product, with English summary.), *Politická Ekonomie*, 48(5), 623-646.
- Izak, V. 2001. "External Factors in Czech Disinflation; a dynamic analysis", *Politická Ekonomie*, 49(4), 493-513.
- Janacek, K., Zamrazilova, E. 2004. "Perspectives of Czech Economy after Entry of the European Union", *Politická ekonomie*, 5, 579-600.
- Janacek, K., Zamrazilova, E. 2005. "Czech Economy: First Year after the EU Entry". *Politická ekonomie*, 5, 579-600.



- Janackova, S. 1999. "Convergence of the Czech Price Level toward European Union Must Be Based on Productivity", *Politicka ekonomie*, 4, 435-448.
- Janda, K., Goodhue, R., Lyons, R., Rausser, G., Simon, L. 1996. "Computable Policy Model of Eastern European Agriculture and Food Industry". *Prague Economic Papers*, 1.
- Kaderabkova, A. 1999. "Economic Growth and Structural Adjustment in Transition (The Case of the Czech Republic)", *Prague Economic Papers*, 4, 298-312.
- Kapicka, M. 1997. "Development of the Czech Foreign Trade in 1993-1996". *Finance a Uver*, 3, 163-175.
- Kejak, M. 1998. "Endogenni rustove modely", *Finance a uver* 7, 445.
- Kejak, M., Vavra, D. 1999a. "Modeling the macroeconomic impact of the CSF on the Czech Republic using the HERMIN model: some preliminary results", *CERGE-EI Discussion Paper* no1999-27.
- Kejak, M., Vavra, D. 1999b. "HERMIN CR", Report to the EU Commission on the project P96-6242R: *Macroeconomics and structural change: common themes between CEE and EU periphery countries*.
- Kejak, M., Vavra, D., 2002. "Factor Accumulation Story: any unfinished business?", *CERGE-EI Working Paper*, no. 220.
- Kejak, M., Seiter, S., Vavra, D. 2004. „Accession Trajectories and Endogenous Growth". *Structural Change and Economic Dynamics*, Vol. 15(1), March.
- Kekak, M., Vavra, D. 1999. "The HERMIN macromodel of the Czech Republic", *Working Paper 1, Ace-Phare project P96-6242-R*, March.
- Klacek, J., Smidkova, K. 1995. *The Demand for Money Function: The Case of the Czech Economy*. Prague, Institute of Economics of the Czech National Bank.
- Kodera, J., Pankova, V. 2002. "Kapitalova vynosnost (Moznosti vyuziti produkcní funkce pro ohodnocování firem v české ekonomice)". *Politicka ekonomie*, 50(2), 209-216.
- Komarek, L. 1997a. „Project of Segments of Structural of Macroeconomic Model of the Czech Republic", *Politicka ekonomie*, 4, 548-562.
- Komarek, L. 1997b. „Standard Macroeconomic Models and Their Application to the Conditions of the Czech Economy in 1993-1996", *Politicka ekonomie*, 6, 817-835.
- Komarek, L. 2002. "[Soucasny vyvoj makroekonomickeho modelovani](#)", *Finance a uver* 2, 51.
- Koumarova, M., Vavra, D. 2000. *K moznostem simulace makroekonomickych dopadu ekologicke danove reformy pomoci modelu HERMIN CR.*, Prubezna zprava k projektu „Metodika prubezneho vyhodnocovani ekonomickych dopadu legislativy na zivotni prostredi", IEEP, Prague.
- Kreidl, V. 1995. "Analysis of the Czech Import and Export Demand". *Finance a Uver*, 12, 695-708.
- Kvasnicka, M. 2003. "Possibilities of Macroeconomic Policy Evaluation on the Basis of Macroaggregates", *Politicka ekonomie*, 6, 866-880.

- Lau, I. M., Pahlke, A., Rutherford, T. F. 1997. "Modeling Economic Adjustment: A Primer in Dynamic General Equilibrium Analysis", *MobyDK project policy paper*, Denmark, October.
- Laxton, D., Pesenti, P. 2003. "Monetary rules for Small, Open, Emerging Economies". *Journal of Monetary Economics*, Elsevier, 50(5), 1109-1146, July.
- Layard, R., Nickell, S., Jackman, R., 1991. *Unemployment, macroeconomic performance and the labour market*. Oxford University Press, Oxford, Great Britain.
- Lewis, J. 1994. *Applied general equilibrium and economic development; present achievements and future trends*, University of Michigan Press, Michigan.
- Lindbeck, A. 1979. "Imported and structural inflation and aggregated demand: The Scandinavian model reconstructed", in: Lindbeck, A. (ed.), *Inflation and Employment in Open Economies*. North-Holland, Amsterdam.
- Lizal, L. 1998. „Depreciation Rates in a Transition Economy: Evidence from Czech Panel Data“. *CERGE-EI Working Paper No. 137*, Prague, December.
- Mandel, M.; Tomsik, V. 2003. "Spotřební funkce a princip Ricardovské ekvivalence v malé otevřené ekonomice". *Politická-Ekonomie*, 51(4), 517-532.
- Masson, P., Symansky, S., Meredith, G. 1990. "MULTIMOD Mark II: A Revised and Extended Model". *Occasional Paper No.71*, International Monetary Fund, Washington.
- Munnell, A. 1993. "An assessment of trends in and economic impacts of infrastructure investment", in *Infrastructure policies for the 1990s*, Paris, OECD.
- Pankova, V. 2003. "Price Relations Analysis of Export in the Czech Republic", *Politická ekonomie*, 4, 533-540.
- Pankova, V. 1996. "Investment Model of the Czech Economy". *Prague Economic Papers*, 1
- Pierse, R. 1998. *WINSOLVE Version 3: An Introductory Guide*, Department of Economics, University of Surrey, June.
- Polak, S., Vavra, D. 2003. *Models Used in the Forecasting and Policy Analysis System in Coats, Laxton and Rose (eds.): The Czech National Bank's Forecasting and Policy Analysis System*, CNB, Prague.
- Potocnik, J., Majcen, B. 1996. *Possible effects of Slovenian integration into the EU – CGE approach*, Analysis Research and Development, IMAD, Ljubljana.
- Ratinger, T. 1995. "The Own, Cross and Expenditure Elasticities of Demand for the Selected Food Groups in the Czech Republic under Economic Transition 1990-1992". *Central-European-Journal-for-Operations-Research-and-Economics*, 3(1), 7-21.
- Ratinger, T., Tousek, Z. 2004. "Vliv přijetí Společné zemědělské politiky Evropské unie na rozvoj české ekonomiky". *Politická ekonomie*, 52(4), 467-483.
- Robinson, S., Kilkenney, M., Hanson, K. 1990. „The USDA/ERS Computable General Equilibrium (CGE) Model of the United States, USDA/ERS“, *Staff Report No. AGES 9049*, Washington D.C.
- Rutherford, T. F, Tarr, D., Rutström, E. 1997. "Morocco's free trade agreement with the EU: A quantitative assessment". *Economic Modelling*, 14, 237-269, April.

- Rutherford, T. F. 1999. "Applied General Equilibrium Modeling with MPSGE as a GAMS Subsystem: An Overview of the Modeling Framework and Syntax", *Computational Economics*, 14, 1-46.
- Saroch, S. 2003. "Fiscal Macroeconomic Stabilization: A new Era?" *Politicka ekonomie*. 3, 373-390.
- Sbornik konference Macromodels 01' AMFET*, Krag, Poland.
- Shoven, J. B., Whalley, J. 1992. *Applying general equilibrium*, Cambridge University Press, Cambridge.
- Simoncic et al. 1999. "The HERMIN Macromodel of Slovenia", *Working Paper submitted to the Commission of the EU under the project P96-6242R*.
- Simoncic, M., Pfajfar, L., Potocnik, P., 1999. "The HERMIN Macromodel of Slovenia". *Working Paper submitted to the Commission of the EU under the project P96-6242R*.
- Sinaesi, B., Van Reenen, J. 2002. "The Returns to Education: A Review of the Empirical Macro-Economic Literature", *Working Paper WP 02/05, Institute of Fiscal Studies (IFS)*, London.
- Sirovatka, T., Zizlavsky, M. 2003. "Unemployment and Work Incentives". *Politicka ekonomie*, 3, 391-406.
- Soustruznik, J. 2002. "Determinanty realnych investic a jejich vyznam v kontextu vyvoje ekonomiky CR". *Finance a uver*, 3, 144-163.
- Stavrev, E. 2000a. "A Small Continuous-Time Macroeconometric Model of the Czech Economy". *Transition Economic Series*, 18, IAS, Vienna, July.
- Stavrev, E. 2000b. "A Comparative Analysis of the Czech Republic and Hungary Using Small Continuous-Time Macroeconometric Models". *Transition Economic Series*, IAS, Vienna, July
- Stavrev, E. 2000c. "Efektivnost menove a fiskalni politiky a determinace nominalniho rovnovazneho kurzu". *Finance a uver*, 9, 464.
- Sujan, I. 1983. *Analyza a prognoza vyvoja ceskoslovenskej ekonomiky na zaklade aplikacii systemu modelov*. VVS Bratislava.
- Svejnar, J. 1996. "Enterprises and Workers in the Transition: Econometric Evidence". *CERGE Prague, Working Paper no. 97*, April.
- Thissen, M. 1999. "Financial CGE models: Two decades of research", *SOM Research Memorandum*, University of Groningen, Groningen.
- Torma, H., Rutherford, T. F. 1992. "General equilibrium tax model for Finland", *Working paper 15/1992*, University of Jyvaskyla, Finland.
- Valencik, R. 2004. "Broad Approach of General Economic Equilibrium", *Politicka ekonomie*, 1, 61-73.
- Vasicek, O. and David, S. 2004. "A Macroeconometric model and stability analysis by parameters". *International Advances in Economic Research, St. Louis: International Atlantic Economic Society*, 10, 4, 238-250.

- Vasicek, O., Fukac, M. 2002. "Makroekonomický model produktu neakcelerující inflaci". *Finance a uver*, 5, 258.
- Vennemo H. 1997. "A dynamic applied general equilibrium model with environmental feedbacks", *Economic Modelling*, 14, 99-154.
- Vonka, D., van der Windt, N. 2005. *Note on the MIT sector model*, Ministry of Industry and Trade of the Czech Republic, mimeo, August.
- Vosvrda, M. 1995. "Disequilibrium Model for the Czech Economy". *Vyzkumna zprava UTIA*, 18/51.
- Welfe, W., Welfe, A., Florczak, W., Sabanty, L. 2002. "The W8-2000 medium-term macroeconomic model of the Czech Republic economy", paper presented at the International Conference *MACROMODELS 2002*, Cedzyna, The Czech Republic, December 4-7.
- Willenbockel D. 1999. "Dynamic applied general equilibrium trade policy analysis in the presence of foreign asset cross-ownership", *Economic Modelling*, 371-388.
- Żółkiewski, Z. 1994. "Welfare gains of elimination of monopolistic competition - CGE estimates for Poland", *RESEARCH bulletin* 3(3), Research Centre for Economic and Statistical Studies, Warsaw.

## **ANNEXES**

---

## RELEVANT EMPIRICAL WORK FOR BUILDING MACROECONOMIC MODELS

### A.1 PRODUCTION AND FACTOR DEMANDS

Most structural macroeconomic models in this review work with use either Cobb-Douglas or CES production technologies (elasticity lower than one) and the derived factor demands are calibrated. Backing from micro evidence is limited though and not always fully usable. For instance, a micro-approach of Kodera and Pankova (2002) estimates elasticity of substitution for five manufacturing sectors on firm-level data from 1998. The labor elasticity varies from 0.67 in textiles to 0.79 in chemistry and the Cobb-Douglas hypothesis cannot be rejected. This contrasts with an older work of Lizal (1998) who analyzes investment behavior on firm level data from early 1990s and rejects the constant returns to scale assumption on the Cobb-Douglas production function. He also finds that exports and domestic sales face similar technological constraints. Many other macro works that estimate an aggregate production function impose the C-D specification (e.g. Navratil and Hurnik 2005, or Hajek and Bezdek, 2001). Some other published work (e.g. Husek, 2000, or Soustruznik, 2002) mostly explore theoretical aspects of modeling production functions or factor demands without giving explicit empirical results.

### A.2 CONSUMER BEHAVIOR

Macro models differ a lot in the specifications of the consumer behavior. While some assume the consumers are myopic in consuming a fixed proportions of their incomes, others work with consumption smoothing through the permanent income hypothesis and habit persistence. Furthermore, most macro models actually assume Riccardian behavior of consumers with respect to taxes and income.

The econometric evidence for the permanent income hypothesis is weak, though. Both Mandel and Tomsik (2003) and Arlt, Cutkova and Radkovsky (2002) find little evidence or reject it (although the former find that consumers rationally adjust their spending with respect to expectations about external sector imbalances). The estimates of the marginal propensity to consume out of income in these works is remarkably close, ranging from 0.68-0.79, although some care has to be taken in interpreting their concepts of disposable income. Mandel and Tomsik also find evidence against the the Riccardian treatment of government expenditure.

### A.3 WAGE BEHAVIOR

Many macro econometric models work with a formalized wage bargaining process, in which the wages are set taking into account productivity movements, relative prices, tax wedge and relative unemployment rates in a Phillips curve mechanism. This is not true for general equilibrium and CGE settings, although there too the Phillips curve relationship emerges relating price inflation to movements in real marginal costs and wage inflation to movements of marginal rate of substitution around their long-term trends. Although, micro evidence on the wage bargaining process is lacking, Phillips curve specifications occur frequently in other labor market research.<sup>56</sup> For instance, Izak (2000, 2001) and Flek (2001) find evidence on the change in the wage bargaining process between the pre- and post-1997/8 periods, with demand (unemployment) having little impact on (wage) inflation in the former period (confirming the relevance of the scenarios explored by Barry et al., 2003, using Hermin CR). Some of the researchers carefully estimate the PC relationships. For instance, Hrebicek and Vlcek (2006) estimate a non-linear price Phillips curve based on the fluctuations in the rate of unemployment around the NAIRU.

---

<sup>56</sup> Micro labor research has also been limited. For instance, Gottwald (2003) investigates individual wage determinants in context of classic human capital methodology (Mincerian regressions). He finds education to be important in wage determination and there is a significant increase in returns to human capital during the transition process, while the nature or sector of employment has a little role in wage determination. In particular, the wage trends in tradable and non-tradable sectors appear similar in 1997-2000 period, while the relative wage of services to agriculture and non-market services has been rising.

# B

---

## MACROECONOMIC MODELS ON THE CZECH ECONOMY BEFORE 1998

The purpose of this section is to give a brief survey on the stage of economic model building in the Czech Republic before 1998.

The core of the econometric and modeling work concentrated on the short-term performance of the economy in the areas key to the success of the transformation strategy, i.e. the monetary sector, fiscal policy, and the foreign sector. Often driven by short-term data properties, the research lacked a more fundamental theoretical basis. The break-up of the socialist economy after 1989 and „the shock-therapy“ of the transition process brought about new economic phenomena that were quite difficult to model. According to Hanousek (1995), the main reason lied in a quite unpredictable behavior of the economy following the series of transformation steps. The lack of an adequate theory behind the transitional behavior of the economy did not allow for many modeling experiments. Second obvious obstacle was the absolute shortage of appropriate and consistent data. The methodology of the Czech Statistical Office changed several times in the course of the first four years of transition.

One of the first attempts to set the scene for the new period of macro modeling was that of Hanousek and Tuma (1995). They proposed a common IS/LM platform (11 equations) for future efforts in the field and concentrated on proper econometric treatment of the available data. Against the unavailability of longer time series and a general transition economic instability they suggested the use of extraneous or mixed estimators and variable coefficient models.<sup>57</sup> No actual model was constructed though, and the question of inclusion of the production side and labor market through a simple Phillips curve relationship was left open until the economy approached more standard patterns of behavior. As regards the production function, the authors plead for a more flexible form than Cobb-Douglas, but no actual estimation was performed. As such, the only important implication of this work was a firm rejection of all attempts to construct a specific model aimed at transitional performance of the economy, based on the argument that it would be impossible to test it and that the economic behavior could be described by standard models provided all information was used efficiently. With respect to the latter point they strongly argued for the use of autoregressive or VAR models in estimation.

The very first macro model with more significant policy-making implications was constructed at the Ministry of Finance in 1996 (Havlicek, 1996). The model, based on the standard theory of Keynesian multiplication, was a very basic one. Apart from the national account identity and its behavioral components, there were few other relationships. Neither the supply side and labor market, nor monetary sector was specifically considered. The model uses quar-

---

<sup>57</sup> Interestingly, some of these suggestions materialized almost a decade later, when researchers began using non-linear Kalman filters to uncover unobserved variables in monetary policy models (see the main text).



terly data with seasonal dummies. Its simplicity reflected to a large extent the stage of macro modeling research in the Czech Republic in mid 1990s. Nevertheless, the model was used at the Ministry of Finance for both the estimation of budget development and the construction of official forecasts of the Ministry. Only medium predictive power, caused to a large extent by the very short time series available, however made the model only one of several tools used in these forecasts. Later, the model was used to analyze shocks to exogenous variables, e.g. a change in the basket decomposition of the Czech crown. The problem of scarcity of reliable and consistent data series, aggravated by methodological changes at the Czech Statistical Office, hampered further progress on the model including through endogenizing supply side and labor market.

The most elaborate macro modeling study of mid 1990s was undertaken by Vosvrda (1995). The project originated as a small aggregate disequilibrium model with 10 behavioral equations covering both the demand and supply sides as well as the labor market with wage and price equations. Using quarterly statistical data on manufacturing, but also results of a business survey on capacity utilization, the model was aimed at short-run performance of the economy. It had been updated several times since its first introduction in 1995 and was enlarged to include the monetary sector too with help of a team from the CNB. However, the model was never much used for monetary policy simulations.

Among partial econometric work, monetary policy has attracted much of the attention. The demand for money function was repeatedly estimated (see e.g. Hanousek et al., 1995a,b or Holub, 1997b), and many studies on mutual causality of various time series and their estimation using ARMA were performed (e.g. Izak, 1996). Possibly the most significant of these projects, constructed by Klacek and Smidkova (1995) later became a part of a larger macro-economic model constructed by Vosvrda (see earlier).

Alarmed by rising current account deficits, researchers also intensively studied the underpinnings of the trade balance evolution. The approaches adopted by different studies estimating the behavioral equations for exports and imports were quite similar (e.g. see Kreidl, 1995 or Kapicka, 1997). On the import side, the domestic output and competitiveness were usually employed as regressors, with the exception of Holub (1997a,b) who also included monetary overhang as an explanatory variable in the demand for imports. On the export side all studies neglected the domestic supply constraint, i.e. implicitly assumed a price setting behavior. All of them used seasonally adjusted quarterly data.

Some research took place on the underpinnings of consumption function (Husek, 1996, Hanousek and Tuma), rejecting the permanent income hypothesis (e.g. with the help of using the mass privatization revenue windfall). Certain attention was also devoted to the analysis of the Czech labor market, mainly with respect to its low unemployment rate throughout the whole transformation process, which stood in sharp contrast to the experience of many other CEEs (and the later Czech experience too!). Boeri and Burda (1997) and Burda et al. (1995) analyzed the role of active labor market policies on tuning of the labor inflows and outflows using nonparametrical methods. A large project was also undertaken on the micro labor market data (Svejnar, 1996). As for agriculture, an early modeling attempt at an integrated structural model of agriculture and food industry sector used a computable policy model of Eastern European Agriculture developed at the UC at Berkeley and known as TAPD (Trade Analysis and Policy Design), see e.g. Janda (1996). The Ministry of Agriculture was involved as well, although the exact extent of the model use in policy design is not known.

---

## THE HCZ5 MODEL TSP DATA BATCH FILES

### C.1: THE FIVE-SECTOR (HCZ5) DATA FILES

#### C.1.1 CZBASICDAT.TSP: BASIC DATA FOR HCZ5 HERMIN MODEL

```
? -----
? TSP batch file to read data from CZDAT.XLS, which was
? generated from the XLS master data XLS file. The entire
? set of "basic" data is written to CZDAT.TLB

?           Last modified March 22, 2006
? -----

OPTIONS LIMERR=10 LIMWARN=1 LIMWNUMC=1;

FREQ A;

SMPL 1995 2004;

READ (FORMAT=EXCEL, FILE='c:\SIM\HCZ5\CZBasicDAT.XLS')
OTV, OT, ONV, ON, OAV, OA, OGV, OG, GTEPD, GSUBPD, GTREPD,
GSRUBPD, YAFS, YRAFS, CONSV, CONS, GV, G, IV, I, DSV, DS, XV,
X, MV, M, KTOT, DEPV, DEPA, DEPT, DEPN, DEPG, GTYSOCE, GSUBTOT,
GTEPDM, LT, LLN, LA, LG, LAEMP, LTEMP, LLNEMP, YWA, YWT, YWN, YWG,
N, LF, NJUV, NELD, NM, UOFF, UB, GTYTOT, GTYC, GTYSOC, GTYPROP, GREVO,
GREVK, GREVPRIV, GTRND, GTRCURR, GTRK, GND, GTRU, IGINFV, GTRABR, GREVABR,
YFN, BPTPRNE, BPTCK, ITV, INV, IAV, IGV, IT, IN, IA, IHV, IH, IG, WIGME,
WIOME, RNL, RNS, RNG,
XWGE, XWFR, XWIT, XWUK, XWNL, XWPO, XWBG, XWRU, XWUKR, XWSD, XWDK, XWUS,
XWLT, XWHU, XWOE, XWSP, XWSL, XWNW, XWFN, XWSW, XWPT, XWCN, XWOT,
MWGE, MWRU, MWIT, MWFR, MWUK, MWNL, MWPO, MWUS, MWCN, MWBG, MWSD, MWSP,
MWJP, MWOE, MWDK, MWFN, MWHU, MWSK, MWSW, MWSKO, MWNW, MWTW, MWUKR, MWTK,
MWBZ, MWIR, MWLT, MWSL, MWMY, MWOT,
CZKDM, CZKILI, CZKFRF, CZKGBP, CZKNLG, CZKUSD, CZKGBF, CZKSEK, CZKESP, CZKEUR,
STATDIS1, STATDIS2, STATDIS3, GDPEZZZ, WIME, STZZZ, YASA, YCU,
GTTI, GVG, GEKG, GREVC
;

WRITE (FORMAT=DATABANK, FILE='C:\SIM\HCZ5\CZBasicDAT.tlb')
OTV, OT, ONV, ON, OAV, OA, OGV, OG, GTEPD, GSUBPD, GTREPD,
GSRUBPD, YAFS, YRAFS, CONSV, CONS, GV, G, IV, I, DSV, DS, XV,
X, MV, M, KTOT, DEPV, DEPA, DEPT, DEPN, DEPG, GTYSOCE, GSUBTOT,
GTEPDM, LT, LLN, LA, LG, LAEMP, LTEMP, LLNEMP, YWA, YWT, YWN, YWG,
N, LF, NJUV, NELD, NM, UOFF, UB, GTYTOT, GTYC, GTYSOC, GTYPROP, GREVO,
GREVK, GREVPRIV, GTRND, GTRCURR, GTRK, GND, GTRU, IGINFV, GTRABR, GREVABR,
YFN, BPTPRNE, BPTCK, ITV, INV, IAV, IGV, IT, IN, IA, IHV, IH, IG, WIGME,
WIOME, RNL, RNS, RNG,
XWGE, XWFR, XWIT, XWUK, XWNL, XWPO, XWBG, XWRU, XWUKR, XWSD, XWDK, XWUS,
XWLT, XWHU, XWOE, XWSP, XWSL, XWNW, XWFN, XWSW, XWPT, XWCN, XWOT,
```

```

MWGE, MWRU, MWIT, MWFR, MWUK, MWNL, MWPO, MWUS, MWCN, MWBG, MWSD, MWSP,
MWJP, MWOE, MWDK, MWFN, MWHU, MWSK, MWSW, MWSKO, MWNW, MWTW, MWUKR, MWTK,
MWBZ, MWIR, MWLT, MWSL, MWMY, MWOT,
CZKDM, CZKILI, CZKFRF, CZKGBP, CZKNLG, CZKUSD, CZKBGF, CZKSEK, CZKESP, CZKEUR,
STATDIS1, STATDIS2, STATDIS3, GDPEZZZ, WIME, STZZZ, YASA, YCU,
GTTI, GVG, GEKG, GREVC
;

```

```
end;
```

### C.1.2 CZBANDCDAT.TSP: EXTRACTING THE BUILDING & CONSTRUCTION DATA

```

? -----
? TSP batch file to read data from CZBandCDAT.XLS, which was
? generated from the XLS master data XLS file. The entire
? set of B&C data is written to CZBandCDAT.TLB

```

```

?           Last modified March 23, 2006
? -----

```

```
OPTIONS LIMERR=10 LIMWARN=1 LIMWNUMC=1;
```

```
FREQ A;
```

```
SMPL 1995 2004;
```

```

READ (FORMAT=EXCEL, FILE='c:\SIM\HCZ5\CZBandCDAT.XLS')
OBCV, OBC, LBC,          LBCEMP, YWBC, IBC, IBCV, DEPBC
;

```

```

WRITE (FORMAT=DATABANK, FILE='C:\SIM\HCZ5\CZBandCDAT.tlb')
OBCV, OBC, LBC,          LBCEMP, YWBC, IBC, IBCV, DEPBC
;

```

```
end;
```

### C.1.3 PRICEDAT.TSP: THE NIGEM INTERNATIONAL PRICE DATA

```

? -----
? TSP batch file to read data from World_Prices.XLS, and
? dumps the data to PRICES.TLB

```

```

?           Last modified February 9, 2006
? -----

```

```
OPTIONS LIMERR=10 LIMWARN=1 LIMWNUMC=1;
```

```
FREQ A;
```

```
SMPL 1995 2004;
```

```

READ (FORMAT=EXCEL, FILE='c:\SIM\HCZ5\World_Prices.XLS')
GEP, ITP, FRP, UKP, NLP, USP, PTP, SDP, SPP, BGP
;

```

```

WRITE (FORMAT=DATABANK, FILE='C:\SIM\HCZ5\World_Prices.tlb')
GEP, ITP, FRP, UKP, NLP, USP, PTP, SDP, SPP, BGP
;

```

```

end;

```

### C.1.4 PRODUCTIONDAT.TSP: THE NIGEM INTERNATIONAL PRODUCTION DATA

```

? -----
? TSP batch file to read data from World_Production.XLS,
? and dump to World_Production.TLB
?
?           Last modified:  February 9, 2006
? -----

```

```

OPTIONS LIMERR=10 LIMWARN=1 LIMWNUMC=1;

```

```

FREQ A;

```

```

SMPL 1995 2004;

```

```

READ (FORMAT=EXCEL, FILE='c:\SIM\HCZ5\World_Production.XLS')
GEIP, FRIP, ITIP, UKIP, NLIP, CRIP, BGIP, SDIP, DKIP, USIP, HUIP,
OEIP, SPIP, NWIP, FNIP, SWIP, PTIP, RUY, GEU
;

```

```

WRITE (FORMAT=DATABANK, FILE='C:\SIM\HCZ5\World_Production.tlb')
GEIP, FRIP, ITIP, UKIP, NLIP, CRIP, BGIP, SDIP, DKIP, USIP, HUIP,
OEIP, SPIP, NWIP, FNIP, SWIP, PTIP, RUY, GEU
;

```

```

end;

```

### C.1.5: HERDATA\_HCZ5.TSP: GENERATED DATA FOR HCZ5 HERMIN MODEL

```

? -----
?
?                               HERDATA.TSP
?           Generates database: HCZ5DB.TLB for Czech Republic
?           Last modified: April 7, 2006
? -----

? Data are read in from the following three TLB database files:

? CZBasicDAT.TLB      : "Basic" data for Czech Republic HCZ5 model
? CZBandCDAT.TLB     : "Basic" data for B&C sector
? World_Price.TLB    : NiGEM world price data, transformed
? World_Production.TLB : NiGEM world production data, transformed

? The objective is to generate all the required HCZ5 HERMIN data
? and to create the TSP database HCZ5DB.TLB

? Important note: All "basic" and world data needed in the complete
? database must be copied over to the complete database (HCZ5DB.TLB)
? by statements of the form:

?           VARIABLE = VARIABLE;

? In all other cases, variables appearing on the right hand side of
? an "=" sign are copied automatically to the new database.
?
? -----

? -----
? Frequency, observation period and data file
? -----

OPTIONS LIMERR=10 LIMWARN=1 LIMWNUMC=1;

? Access the "basic" and world data

FREQ A;
IN CZBasicDAT, CZBandCDAT, World_Prices, World_Production ;

? Set an encompassing data sample period. This data sample
? should at least include all available data, but can extend
? beyond the data sample currently available (1995-2004)

SMPL 1995 2004;

? Set up the model database, HCZ5DB.TLB

OUT HCZ5DB;

? -----
? Trend variables and intervention variables
? -----

? Set time index (T): (1991 = 1, standard for all NMS HERMIN models)

SMPL 1991 2004;
READ T;

```

```
1 2 3 4 5 6 7 8 9 10 11 12 13 14;

T=T ;
print T;

smpl 1995 2004;

? Define within-sample behavioural time variables. These can
? be used in the model to alter time trends out-of-sample.

? Manufacturing          (T)

TOT=T;
TT=T;
TELPRT=T;

? Building & Construction (BC)

TOBC=T;
TBC=T;

? Market services (excluding B&C) (MS)

TOMS=T;
TMS=T;

? Agriculture (A)

TOA=T;
TLA=T;
TKA=T;

? Demographics, labour supply and other

TLFPR=T;
TYAFS=T;

? Define any DUMMY variables

UNITY=1;

? -----
? --- World variables: from NiGEM and local trade weights ---
? -----

? Interest rates (nominal long-term interest rate)

? RNL = long-term interest rate: average interest rate on credits (CZK)
? RNS = short-term interest rate: average interest rate on credits (CZK)
? RNG = Czech government bond rate

? NB: RNG is currently defined as the 3M PRIBOR since data for T-bills
? are not readily available

RNL=RNL;
RNS=RNS;
RNG=RNG;
print RNL, RNS, RNG;

? Industrial production indices for Czech Republic's main trading partners.
? Needs to be further examined for Czech purposes.
```

? EXTRACT: Russia, use GDP (RUY in NiGEM) rather than industrial output

```
RUIP=RUY;
RUIPDOT=100*(RUIP/RUIP(-1)-1);
print RUIPDOT;
```

? EXTRACT: Index of industrial output in Germany; NIGEM

```
GEIP=GEIP;
GEIPDOT=100*(GEIP/GEIP(-1)-1);
print GEIPDOT;
```

? EXTRACT: Index of industrial output in UK; NIGEM

```
UKIP=UKIP;
UKIPDOT=100*(UKIP/UKIP(-1)-1);
print UKIPDOT;
```

? EXTRACT: Index of industrial output in US; NIGEM

```
USIP=USIP;
USIPDOT=100*(USIP/USIP(-1)-1);
print USIPDOT;
```

? EXTRACT: Index of industrial output in France; NIGEM

```
FRIP=FRIP;
FRIPDOT=100*(FRIP/FRIP(-1)-1);
print FRIPDOT;
```

? EXTRACT: Index of industrial output in Italy; NIGEM

```
ITIP=ITIP;
ITIPDOT=100*(ITIP/ITIP(-1)-1);
print ITIPDOT;
```

? EXTRACT: Index of industrial output in the Netherlands; NIGEM

```
NLIP=NLIP;
NLIPDOT=100*(NLIP/NLIP(-1)-1);
print NLIPDOT;
```

? EXTRACT: Index of industrial output in Belgium; NIGEM

```
BGIP=BGIP;
BGIPDOT=100*(BGIP/BGIP(-1)-1);
print BGIPDOT;
```

? EXTRACT: Index of industrial output in Sweden; NIGEM

```
SDIP=SDIP;
SDIPDOT=100*(SDIP/SDIP(-1)-1);
print SDIPDOT;
```

? EXTRACT: Index of industrial output in Denmark; NIGEM

```
DKIP=DKIP;
DKIPDOT=100*(DKIP/DKIP(-1)-1);
print DKIPDOT;
```

? EXTRACT: Index of industrial output in Hungary; NIGEM

```

HUIP=HUIP;
HUIPDOT=100*(HUIP/HUIP(-1)-1);
print HUIPDOT;

? EXTRACT: Index of industrial output in Austria; NIGEM

OEIP=OEIP;
OEIPDOT=100*(OEIP/OEIP(-1)-1);
print OEIPDOT;

? EXTRACT: Index of industrial output in Spain; NIGEM

SPIP=SPIP;
SPIPDOT=100*(SPIP/SPIP(-1)-1);
print SPIPDOT;

? EXTRACT: Index of industrial output in Norway; NIGEM

NWIP=NWIP;
NWIPDOT=100*(NWIP/NWIP(-1)-1);
print NWIPDOT;

? EXTRACT: Index of industrial output in Finland; NIGEM

FNIP=FNIP;
FNIPDOT=100*(FNIP/FNIP(-1)-1);
print FNIPDOT;

? EXTRACT: Index of industrial output in Switzerland; NIGEM

SWIP=SWIP;
SWIPDOT=100*(SWIP/SWIP(-1)-1);
print SWIPDOT;

? EXTRACT: Index of industrial output in Portugal; NIGEM

PTIP=PTIP;
PTIPDOT=100*(PTIP/PTIP(-1)-1);
print PTIPDOT;

? EXTRACT: Input raw export weights

XWGE=XWGE;
XWUK=XWUK;
XWUS=XWUS;
XWFR=XWFR;
XWIT=XWIT;
XWRU=XWRU;
XWNL=XWNL;
XWPO=XWPO;
XWBG=XWBG;
XWUKR=XWUKR;
XWSD=XWSD;
XWDK=XWDK;
XWLT=XWLT;
XWHU=XWHU;
XWOE=XWOE;
XWSP=XWSP;
XWSL=XWSL;
XWNW=XWNW;
XWFN=XWFN;
XWSW=XWSW;
XWPT=XWPT;

```



```
XWCN=XWCN;
XWOT=XWOT;
```

? Derive total of export shares for a subset of trading partners

```
TOTXSHR=(XWGE+XWUK+XWUS+XWFR+XWIT+XWRU+XWNL+XWBG+XWSD+
XWDK+XWHU+XWOE+XWSP+XWNW+XWFN+XWSW+XWPT);
```

? Re-weight the subset of export shares to add to unity

```
XWGE=XWGE/TOTXSHR;
XWUK=XWUK/TOTXSHR;
XWUS=XWUS/TOTXSHR;
XWFR=XWFR/TOTXSHR;
XWIT=XWIT/TOTXSHR;
XWRU=XWRU/TOTXSHR;
XWNL=XWNL/TOTXSHR;
XWBG=XWBG/TOTXSHR;
XWSD=XWSD/TOTXSHR;
XWDK=XWDK/TOTXSHR;
XWHU=XWHU/TOTXSHR;
XWOE=XWOE/TOTXSHR;
XWSP=XWSP/TOTXSHR;
XWNW=XWNW/TOTXSHR;
XWFN=XWFN/TOTXSHR;
XWSW=XWSW/TOTXSHR;
XWPT=XWPT/TOTXSHR;
```

? Construct OW as an export- weighted average of the above variables

```
OW = XWGE*log(GEIP) + XWUK*log(UKIP) + XWUS*log(USIP)
+ XWFR*log(FRIP) + XWIT*log(ITIP) + XWRU*log(RUIP)
+ XWNL*log(NLIP) + XWBG*log(BGIP) + XWSD*log(SDIP)
+ XWDK*log(DKIP) + XWHU*log(HUIP)
+ XWOE*log(OEIP) + XWSP*log(SPIP) + XWNW*log(NWIP)
+ XWFN*log(FNIP) + XWSW*log(SWIP) + XWPT*log(PTIP);
```

```
OW = exp(OW);
OWDOT=100*(OW/OW(-1)-1);
print OW, OWDOT;
```

? EXTRACT: Input raw import weights

```
MWGE=MWGE;
MWRU=MWRU;
MWIT=MWIT;
MWFR=MWFR;
MWUK=MWUK;
MWUS=MWUS;
MWNL=MWNL;
MWPO=MWPO;
MWCN=MWCN;
MWBG=MWBG;
MWSD=MWSD;
MWSP=MWSP;
MWJP=MWJP;
MWOE=MWOE;
MWDK=MWDK;
MWFN=MWFN;
MWHU=MWHU;
MWSK=MWSK;
MWSW=MWSW;
```

MWSKO=MWSKO;  
 MWNW=MWNW;  
 MWTW=MWTW;  
 MWUKR=MWUKR;  
 MWTK=MWTK;  
 MWBZ=MWBZ;  
 MWIR=MWIR;  
 MWLT=MWLT;  
 MWSL=MWSL;  
 MWMY=MWMY;  
 MWOT=MWOT;

? Derive total of import shares for the above subset of trading partners

TOTMSHR= (MWGE+MWUK+MWUS+MWFR+MWIT+MWRU+MWNL+MWPO+MWCN+MWBG+  
 MWSD+MWSP+MWJP+MWOE+MWDK+MWFN+MWSL+MWSW+MWSK+MWNW+  
 MWTW+MWUKR+MWTK+MWBZ+MWIR+MWLT+MWSL+MWMY) ;

? Re-weight the main export shares to add to unity

MWGE=MWGE/TOTMSHR;  
 MWUK=MWUK/TOTMSHR;  
 MWUS=MWUS/TOTMSHR;  
 MWFR=MWFR/TOTMSHR;  
 MWIT=MWIT/TOTMSHR;  
 MWRU=MWRU/TOTMSHR;  
 MWNL=MWNL/TOTMSHR;  
 MWPO=MWPO/TOTMSHR;  
 MWCN=MWCN/TOTMSHR;  
 MWBG=MWBG/TOTMSHR;  
 MWSD=MWSD/TOTMSHR;  
 MWSP=MWSP/TOTMSHR;  
 MWJP=MWJP/TOTMSHR;  
 MWOE=MWOE/TOTMSHR;  
 MWDK=MWDK/TOTMSHR;  
 MWFN=MWFN/TOTMSHR;  
 MWSL=MWSL/TOTMSHR;  
 MWSW=MWSW/TOTMSHR;  
 MWSK=MWSK/TOTMSHR;  
 MWNW=MWNW/TOTMSHR;  
 MWTW=MWTW/TOTMSHR;  
 MWUKR=MWUKR/TOTMSHR;  
 MWTK=MWTK/TOTMSHR;  
 MWBZ=MWBZ/TOTMSHR;  
 MWIR=MWIR/TOTMSHR;  
 MWLT=MWLT/TOTMSHR;  
 MWSL=MWSL/TOTMSHR;  
 MWMY=MWMY/TOTMSHR;

? EXTRACT: Manufacturing output prices (NIGEM)

GEP=GEP;  
 ITP=ITP;  
 FRP=FRP;  
 UKP=UKP;  
 NLP=NLP;  
 USP=USP;  
 PTP=PTP;  
 SDP=SDP;  
 SPP=SPP;  
 BGP=BGP;

? Convert to local currency; Index 1995=1

```
? First use original currencies prior to 2002

? The new euro currency prices      (Germany, Italy, France,
? Spain, the Netherlands and Belgium)

? EXTRACT: Nominal exchange rate of the CZK against other currencies
? prior to euro zone implementation in 2002

smpl 1995 2001;

? Euro currencies prior to 2002

CZKDM=CZKDM;
CZKILI=CZKILI;
CZKFRF=CZKFRF;
CZKNLG=CZKNLG;
CZKBGF=CZKBGF;
CZKESP=CZKESP;
CZKEUR=CZKEUR;

? Non-euro currencies prior to 2002

CZKUSD=CZKUSD;
CZKGBP=CZKGBP;
CZKSEK=CZKSEK;

? Switch to euro initial parities from January 1, 2002, but keep
? notional national currencies

smpl 2002 2004;

? Euro currencies post 2002

CZKDM=CZKEUR/1.956;
CZKILI=CZKEUR/1936.0;
CZKFRF=CZKEUR/6.56;
CZKNLG=CZKEUR/2.204;
CZKBGF=CZKEUR/40.34;
CZKESP=CZKEUR/166.4;
CZKEUR=CZKEUR;

? Non-euro currencies post 2002

CZKUSD=CZKUSD;
CZKGBP=CZKGBP;
CZKSEK=CZKSEK;

? Re-set full sample period

smpl 1995 2004;
print CZKDM, CZKILI, CZKFRF, CZKNLG, CZKBGF, CZKESP;
print CZKUSD, CZKGBP, CZKSEK, CZKEUR;

? Convert foreign currency price indices to local currency

PGE=GEP*(CZKDM/18.51783399);
PGEDOT=100*(PGE/PGE(-1)-1);

PITA=ITP*(CZKILI/0.016303656);
PITADOT=100*(PITA/PITA(-1)-1);
```

```

PFR=FRP*(CZKFRF/5.316743083);
PFRDOT=100*(PFR/PFR(-1)-1);

PSP=SPP*(CZKESP/0.212844387);
PSPDOT=100*(PSP/PSP(-1)-1);

PNL=NLP*(CZKNLG/16.53054545);
PNLDOT=100*(PNL/PNL(-1)-1);

PBG=BGP*(CZKBGF/0.900011581);
PBGDOT=100*(PBG/PBG(-1)-1);

? The non-euro-zone prices (UK, Sweden, USA)

PUK=UKP*(CZKGBP/41.89231225);
PUKDOT=100*(PUK/PUK(-1)-1);

PSD=SDP*(CZKSEK/3.723450593);
PSDDOT=100*(PSD/PSD(-1)-1);

PUS=USP*(CZKUSD/26.54516206);
PUSDOT=100*(PUS/PUS(-1)-1);

print PGE, PITA, PFR, PSP, PNL, PBG, PUK, PSD, PUS;

? Construct world price index in local (CZECH) currency
? based on manufacturing prices in Germany, USA, Italy, France,
? UK, the Netherlands, Belgium, Sweden and Spain.
? Re-weight the export weights for Germany, USA, Italy,
? France, UK, Netherlands, Belgium, Sweden and Spain

XW1=XWGE/(XWGE+XWUS+XWIT+XWFR+XWUK+XWNL+XWBG+XWSD+XWSP);
XW2=XWUS/(XWGE+XWUS+XWIT+XWFR+XWUK+XWNL+XWBG+XWSD+XWSP);
XW3=XWIT/(XWGE+XWUS+XWIT+XWFR+XWUK+XWNL+XWBG+XWSD+XWSP);
XW4=XWFR/(XWGE+XWUS+XWIT+XWFR+XWUK+XWNL+XWBG+XWSD+XWSP);
XW5=XWUK/(XWGE+XWUS+XWIT+XWFR+XWUK+XWNL+XWBG+XWSD+XWSP);
XW6=XWNL/(XWGE+XWUS+XWIT+XWFR+XWUK+XWNL+XWBG+XWSD+XWSP);
XW7=XWBG/(XWGE+XWUS+XWIT+XWFR+XWUK+XWNL+XWBG+XWSD+XWSP);
XW8=XWSD/(XWGE+XWUS+XWIT+XWFR+XWUK+XWNL+XWBG+XWSD+XWSP);
XW9=XWSP/(XWGE+XWUS+XWIT+XWFR+XWUK+XWNL+XWBG+XWSD+XWSP);

TEMP=XW1+XW2+XW3+XW4+XW5+XW6+XW7+XW8+XW9;
print TEMP;

PWORLD=XW1*log(PGE) + XW2*log(PUS) + XW3*log(PITA) + XW4*log(PFR) +
        XW5*log(PUK) + XW6*log(PNL) + XW7*log(PBG) + XW8*log(PSD) +
        XW9*log(PSP);

PWORLD=exp(PWORLD);
PWORLDOT=100*(PWORLD/PWORLD(-1)-1);
print PWORLD, PWORLDOT;

? Construct an import price proxy in local (CZECH) currency
? based on manufacturing prices in Germany, USA, Italy, France,
? UK, the Netherlands, Belgium, Sweden and Spain.
? Re-weight the export weights for Germany, USA, Italy,
? France, UK, Netherlands, Belgium, Sweden and Spain

MW1=MWGE/(MWGE+MWUS+MWIT+MWFR+MWUK+MWNL+MWBG+MWSD+MWSP);

```

```

MW2=MWUS/ (MWGE+MWUS+MWIT+MWFR+MWUK+MWNL+MWBG+MWSD+MWSP);
MW3=MWIT/ (MWGE+MWUS+MWIT+MWFR+MWUK+MWNL+MWBG+MWSD+MWSP);
MW4=MWFR/ (MWGE+MWUS+MWIT+MWFR+MWUK+MWNL+MWBG+MWSD+MWSP);
MW5=MWUK/ (MWGE+MWUS+MWIT+MWFR+MWUK+MWNL+MWBG+MWSD+MWSP);
MW6=MWNL/ (MWGE+MWUS+MWIT+MWFR+MWUK+MWNL+MWBG+MWSD+MWSP);
MW7=MWBG/ (MWGE+MWUS+MWIT+MWFR+MWUK+MWNL+MWBG+MWSD+MWSP);
MW8=MWSD/ (MWGE+MWUS+MWIT+MWFR+MWUK+MWNL+MWBG+MWSD+MWSP);
MW9=MWSP/ (MWGE+MWUS+MWIT+MWFR+MWUK+MWNL+MWBG+MWSD+MWSP);

TEMP=MW1+MW2+MW3+MW4+MW5+MW6+MW7+MW8+MW9;
print TEMP;

? German rate of unemployment (URGE) from NiGEM

URGE = GEU;
print URGE;

? -----
? EXTRACT:          Total Investment Data (IV, I)
? Both nominal and real data are available, so we input both
? and introduce a statistical discrepancy to the real series.
? An alternative is to use nominal shares for real vars too.
? -----

IV=IV;
I=I;
IDOT=100*(I/I(-1)-1);
PI=IV/I;
PIDOT=(PI/PI(-1)-1)*100;
print IV, I, PI, PIDOT ;

? Introduce data for total capital stock (KTOT) and derive
? investment/stock ratio (IRAT)

KTOT=KTOT;
IRAT=I/KTOT;
print I, KTOT, IRAT;

? Define real interest rate (RRSA)

CONSV=CONSV;
CONS=CONS;
PCONS=CONSV/CONS;
PCONSDOT=100*(PCONS/PCONS(-1)-1);

RRSA=RNS-PCONSDOT;
print RNS, PCONSDOT, RRSA;

? Reset RRSA to 8 per cent

RRSA=8.0;

?-----
?          Manufacturing sector (T)
? Input data: OTV, OT, LT, LTEMP, ITV, IT, DEPT, YWTC
?-----

? EXTRACT: OTV, OT

OTV=OTV;

```

```

OT=OT;

POT=OTV/OT;
POTDOT=100*(POT/POT(-1)-1);
OTDOT=100*(OT/OT(-1)-1);
print OTV, OT, POT, POTDOT, OTDOT;

? EXTRACT: ITV, IT

ITV=ITV;
IT=IT;

PIT=ITV/IT;
PITDOT=100*(PIT/PIT(-1)-1);
ITRAT=100*IT/OT;
print ITV, IT, PIT, ITRAT, PITDOT;

? EXTRACT: Real depreciation in T-sector (DEPT)

DEPT=DEPT;

? Generate capital stock in T-sector. Note initial stock.

smpl 1995 1995;
KT=IT/IRAT;
SMPL 1996 2004;
GENR KT=KT(-1)+IT-DEPT;
SMPL 1995 2004;
DEPTRAT=DEPT/KT(-1);
print KT, IT, DEPT, DEPTRAT;

? Number of gainfully occupied persons and employees

? EXTRACT: LT, LTEMP and convert to thousands

LT=LT/1000;
LTEMP=LTEMP/1000;

? Calculate the number of self-employed

LTSEMP=LT-LTEMP;

? Define the SE to total employment ratio for use in the model

SETRAT=LTSEMP/LT;
print LT, LTEMP, LTSEMP, SETRAT;

? Labour productivity and growth rate

LPRT=OT/LT;
ELPRT=LPRT;

LPRTDOT=100*(LPRT/LPRT(-1)-1);
print LPRT, LPRTDOT;

?-----
? --- Wage Bill ---
?-----

? EXTRACT YWT

YWT=YWT;

```

```

? Calculate the average annual earnings of employees (WT)

WT=YWT/LTEMP;
WTDOT=(WT/WT(-1)-1)*100;
print WT, WTDOT;

?-----
? Cost of capital - manufacturing sector
?-----

PKT=PIT*(DEPTRAT+RRSA/100);
print PKT, PIT, DEPTRAT, RRSA;

RFPT=WT/PKT;
RFPTDOT=100*(RFPT/RFPT(-1)-1);
ERFPT=(RFPT+0.75*RFPT(-1))/(1.0+0.75);
print RFPT, RFPTDOT;

?-----
? Unit labour cost and growth rate of unit labour cost
?-----

ULCT=YWT/OT;
ULCTDOT=100*(ULCT/ULCT(-1)-1);

? Real unit labour cost and growth rate of real unit labour cost

RULCT=ULCT/POT;
RULCTDOT=100*(RULCT/RULCT(-1)-1);
print ULCT, ULCTDOT, RULCTDOT;

? Competition measure (in CZECH currency terms)

PCOMPT=POT/PWORLD;
print PCOMPT, PWORLD, POT;

? Labour (wage) share of added-value (LSHRT)

LSHRT=100*YWT/OTV;
print LSHRT;

? Corporate profits (notional)

YCT=OTV-YWT;
YCTRAT=100*YCT/OTV;
print OTV, YWT, YCT, YCTRAT;

? Profit repatriation (YCTREP), initially set to zero

YCTREP=0.0;

? Fraction of manufacturing profits that are repatriated (set at 20%)

KYCTREP=0.0;

? -----
?           Building & Construction sector (BC)
? Input data: OBCV, OBC, LBC, LBCEMP, IBCV, IBC, DEPBC, YWBC
?
? -----

```

```

? EXTRACT: OBCV, OBC

OBCV=OBCV;
OBC=OBC;

POBC=OBCV/OBC;
POBCDOT=100*(POBC/POBC(-1)-1);
OBCDOT=100*(OBC/OBC(-1)-1);
print OBCV, OBC, OBCDOT POBCDOT;

? EXTRACT: IBCV, IBC

IBCV=IBCV;
IBC=IBC;

PIBC=IBCV/IBC;
PIBCDOT=100*(PIBC/PIBC(-1)-1);

IBCRAT=100*IBC/OBC;
print IBCV, IBC, PIBC, PIBCDOT, IBCRAT;

? EXTRACT: Depreciation in BC-sector

DEPBC=DEPBC;

? Generate capital stock in BC-sector. Note initial stock.

smpl 1995 1995;
KBC=IBC/IRAT;
SMPL 1996 2004;
GENR KBC=KBC(-1)+IBC-DEPBC;
SMPL 1995 2004;
DEPBCRAT=DEPBC/KBC(-1);
print IBC, KBC, DEPBCRAT;

? Number of gainfully occupied persons

? EXTRACT: LLBC and LBCEMP and convert to thousands

LBC=LBC/1000;
LBCEMP=LBCEMP/1000;

? Calculate the number of self-employed

LBCSEMP=LBC-LBCEMP;

? Define the SE to total employment ratio for use in the model

SEBCRAT=LBCSEMP/LBC;
print LBC, LBCEMP, LBCSEMP, SEBCRAT;

? Labour productivity and growth rate

LPRBC=OBC/LBC;
LPRBCDOT=100*(LPRBC/LPRBC(-1)-1);
print LPRBC, LPRBCDOT;

?-----
? Wage bill BC-sector
?-----

? EXTRACT: YWBC

```



```

YWBC=YWBC;

? Calculate average annual earnings (WBC)

WBC=YWBC/LBCEMP;
WBCDOT=(WBC/WBC(-1)-1)*100;
print WBC, WBCDOT;

? Cost of Capital

PKBC=PIBC*(DEPBCRAT+RRSA/100);
print PKBC, PIBC, DEPBCRAT, RRSA;

RFPBC=WBC/PKBC;
ERFPBC=(RFPBC+0.75*RFPBC(-1))/(1.0+0.75);
print RFPBC, ERFPBC;

? Unit labour cost (nominal) and growth rate

ULCBC=YWBC/OBC;
ULCBCDOT=100*(ULCBC/ULCBC(-1)-1);

? Real unit labour cost and labour share

RULCBC=ULCBC/POBC;
RULCBCDOT=100*(RULCBC/RULCBC(-1)-1);
print ULCBC, ULCBCDOT, RULCBCDOT;

? Labour (wage) share of added value (LSHRBC)

LSHRBC=100*YWBC/OBCV;
print LSHRBC;

? Corporate profits, (notional)

YCBC=OBCV-YWBC;
YCBCRAT=100*YCBC/OBCV;
print OBCV, YWBC, YCBC, YCBCRAT;

? -----
?           Market services sector (MS)
? Input data: ONV, ON, LLN, LLNEMP, INV, IN, DEPN, YWN
?
? Derive the MS data residually by subtracting BC from N
? -----

? EXTRACT: ONV, ONS

ONV=ONV;
OMSV=ONV-OBCV;
ON=ON;
OMS=ON-OBC;

PON=ONV/ON;
PONDOT=100*(PON/PON(-1)-1);
ONDOT=100*(ON/ON(-1)-1);
print ONV, ON, ONDOT PONDOT;

POMS=OMSV/OMS;

```

```

POMSDOT=100*(POMS/POMS(-1)-1);
OMSDOT=100*(OMS/OMS(-1)-1);
print OMSV, OMS, OMSDOT POMSDOT;

? EXTRACT: INV, IN

INV=INV;
IMSV=INV-IBCV;
IN=IN;
IMS=IN-IBC;

PIN=INV/IN;
PINDOT=100*(PIN/PIN(-1)-1);

PIMS=IMSV/IMS;
PIMSDOT=100*(PIMS/PIMS(-1)-1);

INRAT=100*IN/ON;
print INV, IN, PIN, PINDOT, INRAT;

IMSRAT=100*IMS/OMS;
print IMSV, IMS, PIMS, PIMSDOT, IMSRAT;

? EXTRACT: Depreciation in N-sector

DEPN=DEPN;
DEPMS=DEPN-DEPBC;

? Generate capital stock in N-sector. Note initial stock.

smpl 1995 1995;
KN=IN/IRAT;
SMPL 1996 2004;
GENR KN=KN(-1)+IN-DEPN;
SMPL 1995 2004;
DEPNRAT=DEPN/KN(-1);
print IN, KN, DEPNRAT;

? Generate capital stock in MS-sector. Note initial stock.

smpl 1995 1995;
KMS=IMS/IRAT;
SMPL 1996 2004;
GENR KMS=KMS(-1)+IMS-DEPMS;
SMPL 1995 2004;
DEPMSRAT=DEPMS/KMS(-1);
print IMS, KMS, DEPMSRAT;

? Number of gainfully occupied persons

? EXTRACT: LLN and LLNEMP (converting to thousands)

LLN=LLN/1000;
LMS=LLN-LBC;
LLNEMP=LLNEMP/1000;
LMSEMP=LLNEMP-LBCEMP;

? Calculate the number of self-employed

LLNSEMP=LLN-LLNEMP;
LMSSEMP=LMS-LMSEMP;

? Define the SE to total employment ratio for use in the model

```

```

SEMSRAT=LMSSEMP/LMS;
print LMS, LMSEMP, LMSSEMP, SEMSRAT;

? Labour productivity and growth rate

LPRN=ON/LLN;
LPRNDOT=100*(LPRN/LPRN(-1)-1);
print LPRN, LPRNDOT;

LPRMS=OMS/LMS;
LPRMSDOT=100*(LPRMS/LPRMS(-1)-1);
print LPRMS, LPRMSDOT;

?-----
? Wage bill N-sector
?-----

? EXTRACT: YWN

YWN=YWN;
YWMS=YWN-YWBC;

? Calculate average annual earnings (WN)

WN=YWN/LLNEMP;
WNDOT=(WN/WN(-1)-1)*100;
print WN, WNDOT;

WMS=YWMS/LMSEMP;
WMSDOT=(WMS/WMS(-1)-1)*100;
print WMS, WMSDOT;

? Cost of Capital

PKN=PIN*(DEPNRAT+RRSA/100);
print PKN, PIN, DEPNRAT, RRSA;

RFPN=WN/PKN;
ERFPN=(RFPN+0.75*RFPN(-1))/(1.0+0.75);
print RFPN, ERFPN;

PKMS=PIMS*(DEPMSRAT+RRSA/100);
print PKMS, PIMS, DEPMSRAT, RRSA;

RFPMS=WMS/PKMS;
ERFPMS=(RFPMS+0.75*RFPMS(-1))/(1.0+0.75);
print RFPMS, ERFPMS;

? Unit labour cost (nominal) and growth rate

ULCN=YWN/ON;
ULCNDOT=100*(ULCN/ULCN(-1)-1);

ULCMS=YWMS/OMS;
ULCMSDOT=100*(ULCMS/ULCMS(-1)-1);

? Real unit labour cost and labour share

RULCN=ULCN/PON;
RULCNDOT=100*(RULCN/RULCN(-1)-1);
print ULCN, ULCNDOT, RULCNDOT;

```

```

RULCMS=ULCMS/POMS;
RULCMSDOT=100*(RULCMS/RULCMS(-1)-1);
print ULCMS, ULCMSDOT, RULCMSDOT;

? Labour (wage) share of added value (LSHRN)

LSHRN=100*YWN/ONV;
print LSHRN;

LSHRMS=100*YWMS/OMSV;
print LSHRMS;

? Corporate profits, (notional)

YCN=ONV-YWN;
YCNRAT=100*YCN/ONV;
print ONV, YWN, YCN, YCNRAT;

YCMS=OMSV-YWMS;
YCMSRAT=100*YCMS/OMSV;
print OMSV, YWMS, YCMS, YCMSRAT;

?-----
?      Agriculture sector (A)
?      Input data: OAV, OA, LA, YWA
?-----

? EXTRACT: OAV, OA

OAV=OAV;
OA=OA;

OADOT=100*(OA/OA(-1)-1);
POA=OAV/OA;
POADOT=100*(POA/POA(-1)-1);
print OAV, OA, POA, OADOT POADOT;

?-----
? Number of gainfully occupied persons
?-----

? EXTRACT: LA and LAEMP

LA=LA/1000;
LAEMP=LAEMP/1000;
LASEMP=LA-LAEMP;

? Define the SE to total employment ratio for use in the model

SEARAT=LASEMP/LA;
print LA, LAEMP, LASEMP, SEARAT;

? Productivity in agriculture (LPRA)

LPRA=OA/LA;
LPRADOT=100*(LPRA/LPRA(-1)-1);
print LPRA, LPRADOT;

? EXTRACT: IAV, IA

```

```

IAV=IAV;
IA=IA;

PIA=IAV/IA;
PIADOT=100*(PIA/PIA(-1)-1);
print IAV, IA, PIA, PIADOT;

IARAT=100*IA/OA;
print IA, OA, IARAT;

? EXTRACT: Depreciation in A-sector (DEPA)

DEPA=DEPA;

? Generate capital stock in A-sector. Note initial stock.

smpl 1995 1995;
KA=IA/IRAT;
SMPL 1996 2004;
GENR KA=KA(-1)+IA-DEPA;
SMPL 1995 2004;
DEPARAT=DEPA/KA(-1);
print IA, KA, DEPARAT;

? Wage bill

? EXTRACT: YWA

YWA=YWA;

? Calculate average annual wage earnings in ag (WA)

WA=YWA/LAEMP;
WADOT=(WA/WA(-1)-1)*100;
print WA, WADOT;

? Corporate profits, (notional)

YCA=OAV-YWA;
YCARAT=100*YCA/OAV;
print OAV, YWA, YCA, YCARAT;

? Labour (wage) share of added value (LSHRA)

LSHRA=100*YWA/OAV;
print LSHRA;

?-----
?      Government sector (G)
?      Input data: OGV, OG, LG, YWG
?-----

? EXTRACT: OGV OG

OGV=OGV;
OG=OG;

OGDOT=100*(OG/OG(-1)-1);
POG=OGV/OG;
POGDOT=100*(POG/POG(-1)-1);

```

```

print OGV, OG, POG, OGDOT POGDOT;

? EXTRACT: LG

LG=LG/1000;

? Labour productivity in G-sector (LPRG)

LPRG=OG/LG;
LPRGDOT=100*(LPRG/LPRG(-1)-1);
print LPRG, LPRGDOT;
print LPRT, LPRN, LPRA, LPRG;
print LPRTDOT, LPRNDOT, LPRADOT, LPRGDOT;

? Wage bill

? EXTRACT: YWG

YWG=YWG;

WG=YWG/LG;
WGDOT=(WG/WG(-1)-1)*100;
print WG, WGDOT;

? EXTRACT: IGV, IG

IGV=IGV;
IG=IG;

PIG=IGV/IG;
PIGDOT=100*(PIG/PIG(-1)-1);
print IGV, IG, PIG, PIGDOT;

? Investment rate in G sector

IGRAT=100*IG/OG;
print IG, OG, IGRAT;

? EXTRACT: Depreciation in G-sector (DEPG)

DEPG=DEPG;

? Generate capital stock in A-sector. Note initial stock.

smpl 1995 1995;
KG=IG/IRAT;
SMPL 1996 2004;
GENR KG=KG(-1)+IG-DEPG;
SMPL 1995 2004;
DEPGRAT=DEPG/KG(-1);
print IG, KG, DEPGRAT;

OGNWV=OGV-YWG;
OGNWRAT=100*OGNWV/OGV;
OGNW=OGNWV/POG;
print OGV, YWG, OGNWV, OGNW, OGNWRAT;

? -----
?      Demographic and labour supply data
?      Input data: N, NJUV, NELD, NM, LF, UOFF, UB
? -----

```

```
? Population is defined as follows:
? N:      total population
? NJUV:   population less than working age 0-14
? NWORK:  population of working age 15-64
? NELD:   population over working age 64-

? EXTRACT: NJUV, NELD, N

NJUV=NJUV/1000;
NELD=NELD/1000;
N=N/1000;

? Working age population (NWORK)

NWORK = N - (NJUV+NELD);
print N, NJUV, NWORK, NELD;

? The "dependent" population (for use as social welfare payments base)

NDEP = NJUV+NELD;

? EXTRACT NM: Net migration (negative is out-migration)

NM=NM/1000;

? EXTRACT LF:

LF=LF/1000;

? Generate numbers unemployed (ILO measure)

U=LF-(LT+LBC+LMS+LA+LG);
print LF, LT, LBC, LMS, LA, LG, U;

? Migration rate (NMRAT)

NMRAT=NM/LF(-1);
print NM, NMRAT;

? Participation rate in percent

LFPR=100*LF/NWORK;
print LF, NWORK, LFPR;

? Gainfully occupied persons (total, private non-ag, private and non-ag)

? Total (L)

L=LT+LBC+LMS+LA+LG;

? Private, non-agricultural (LPNA)

LPNA=LT+LBC+LMS;

? Private (LP)

LP=LPNA+LA;

? Non-agricultural (LNA)

LNA=LPNA++LG;
```

```

? Total self-employed LSEMP (excludes all of LG)
LSEMP=LASEMP+LTSEMP+LBCEMP+LMSSEMP;

? Total employees LEMP
LEMP=L-LSEMP;

? Numbers employed in non-agricultural sector
? Employees LNAEMP and self-employed LNASEMP
LNAEMP=LTEMP+LBCEMP+LMSEMP+LG;
LNASEMP=LNA-LNAEMP;

? Numbers employed in private non-agricultural sector
? Employees LPNAEMP and self-employed LPNASEMP
LPNAEMP=LTEMP+LBCEMP+LMSEMP;
LPNASEMP=LPNA-LPNAEMP;

? Alternative unemployment rates; UOFF is registered unemployed,
? UB is income-support recipients

? EXTRACT: UOFF, UB

UOFF=UOFF/1000;
UROFF=100*(UOFF/LF);

? The data for UB are experimental: need to check

UB=UB/1000;
URUB=100*(UB/LF);

? Define ILO unemployment rate

UR=100*(U/LF);
URP=UR;

print UR UROFF URUB;

? Moving average unemployment rate over two periods

URBAR=(UR+UR(-1))/2.0;
print UR, URBAR;

? -----
?           National Accounting Expenditure data
?
? Input data: CONSV, CONS, GV, G, DSV, DS, XV, X, MV, M
? -----

? Construction of GDP (at market prices) on an expenditure basis (GDPE)

? EXTRACT: CONSV, CONS

CONSV=CONSV;
CONS=CONS;

PCONS=CONSV/CONS;
PCONSDOT=100*(PCONS/PCONS(-1)-1);
print CONSV, CONS, PCONS, PCONSDOT;

```



```

? Government consumption GV

? EXTRACT: GV, G:

GV=GV;
G=G;

PG=GV/G;
PGDOT=100*(PG/PG(-1)-1);
print GV, G, PG,PGDOT;

GENW=GV-YWG;
print GV, YWG, GENW;

? Private & public housing investment (share of gov set notionally at 20%)

? EXTRACT: IHV, IH

IHV=IHV;
IH=IH;

PIH=IHV/IH;

IHGV=0.2*IHV;
IHPV=IHV-IHGV;
IHG=IHGV/PIH;
IHP=IHPV/PIH;
print IHV, IH, PIH;
print IHGV, IHG;
print IHPV, IHP;

? Calculate the residual between NA total investment (IV, I) and
? the sum of sectoral investment

STDISI = (I) - (IT+IBC+IMS+IA+IG + IH);
STDISIV = (IV) - (ITV+IBCV+IMSV+IAV+IGV + IHV);

STDISIR =100*(STDISI/I);
STDISIVR=100*(STDISIV/IV);
print STDISI, STDISIR;
print STDISIV, STDISIVR;

? Private non-housing investment (IPV, IP)

IPV=ITV+IBCV+IMSV+IAV;
IP=IT+IBC+IMS+IA;

? Private sector non-housing capital stock

KP=KT+KBC+KMS+KA;

? Total non-housing investment (INH)

INH=I-IH;

? EXTRACT: Fraction of public sector investment that consists of
? machinery and equipment (ME)

WIGME=WIGME;

? EXTRACT: Fraction of private sector investment that consists of
? machinery and equipment (ME)

```

```

WIOME=WIOME;

print WIGME, WIOME;

? Input data on investment activity carried out by the N-sector
? on behalf of the G-sector (e.g., roads, airports, harbours, etc.)
? We have total G investment from GFS stat - compute ISMGV as a residuum

? EXTRACT: Total investment by & for public sector (IGINFV)

IGINFV=IGINFV;

? Derive ISMGV residually

ISMGV=IGINFV-IGV;

ISMG=ISMGV/PIG;
IGINF=IGINFV/PIG;

? Generate stock of (public) infrastructure (KGINF)
? Note initial stock

print IGINF;
SMPL 1995 1995;
KGINF=(IG+ISMG)/IRAT;
SMPL 1996 2004;
GENR KGINF=IGINF+(1-DEPGRAT)*KGINF(-1);
SMPL 1995 2004;
print IG, ISMG, KGINF;

IGINFME=WIGME*IGINF;
IGINFBC=IGINF-IGINFME;
IOTH=INH-IGINF;
IOTHME=WIOME*IOTH;
IOTHBC=IOTH-IOTHME;

? Define total non-housing investment by two types of good:
? building & construction and machinery & equipment.
? Note that IBCTOT should be carefully distinguished from investment
? "by" the B&C sector. This may be disaggregated from the aggregate
? N sector at a later stage, where the notation IBC will be used.

IBCTOT=IGINFBC+IOTHBC;
IMETOT=IGINFME+IOTHME;

? Disaggregate public investment by two types of good

IGINFME=IMETOT-IOTHME;
IGINFBC=IBCTOT-IOTHBC;

? EXTRACT: DSV, DS:

DSV=DSV;
DS=DS;

PDS=DSV/DS;

? Generate stock level of inventories (ST)
? Assume initial stock/output ratio is 25%

SMPL 1995 1995;
ST=0.25*OT;

```

```

SMPL 1996 2004;
GENR ST=DS+ST(-1);
SMPL 1995 2004;
print DSV, DS, ST;

? Exports and imports

? EXTRACT: XV, X

XV=XV;
X=X;

XDOT=100*(X/X(-1)-1);
PX=XV/X;
PXDOT=100*(PX/PX(-1)-1);

? EXTRACT: MV, M

MV=MV;
M=M;

MDOT=100*(M/M(-1)-1);
PM=MV/M;
PMDOT=100*(PM/PM(-1)-1);
print XV, X, XDOT, PX, PXDOT;
print MV, M, MDOT, PM, PMDOT;

? Construction of NTS (Net Trade Surplus)

NTSV = XV-MV;
NTS = X-M;

? Construction of gross domestic absorption

GDAV = CONSV + IV + GV + DSV;
GDA = CONS + I + G + DS;

PGDA = GDAV/GDA;
PGDADOT = 100*(PGDA/PGDA(-1)-1);

GDPEV = GDAV + NTSV;

? EXTRACT: Total GDPE (GDPEZZZ)

GDPE=GDPEZZZ;
print GDPE;

STDISE = GDPE-(GDA + NTS);
STDISER=STDISE/GDPE*100;
print STDISER;

GDPEDOT=100*(GDPE/GDPE(-1)-1);
PGDPE = GDPEV/GDPE;
PGDPEDOT = 100*(PGDPE/PGDPE(-1)-1);
print GDPEV, GDPE, GDPEDOT, PGDPE;

? Define expenditure/GDPE ratios for main components

CONSVR=CONSV/GDPEV;
IVR=IV/GDPEV;
GVR=GV/GDPEV;
NTSVR=NTSV/GDPEV;

```

```

print CONSVR, IVR, GVR, NTSVR ;

NTSR = 100*(NTS/GDPE);

? Definition of GDP at factor costs

? EXTRACT: YAFS, YRAFS (adjustment for financial services)

YAFS=YAFS;
YRAFS=YRAFS;

PYAFS= YAFS/YRAFS;

? Construction of GDP at factor costs

GDPFCV=OTV+OBCV+OMSV+OAV+OGV-YAFS;
GDPFC=OT+OBC+OMS+OA+OG-YRAFS;
GDPFCPC=GDPFC/N;
GDPFCDOT=100*(GDPFC/GDPFC(-1)-1);
PGDPFC=GDPFCV/GDPFC;
PGDPFCDT=100*(PGDPFC/PGDPFC(-1)-1);
print GDPFCV, GDPFC, GDPFCDOT, PGDPFC, PGDPFCDT;

? -----
? I/O weights for definition of weighted final demand measures
?
? Initially, these are taken from a previous calibration, needs to
? be checked with a more recent I/O data
? -----

PARAM AIOTC  0.116951;      ?  0.1581 (old);
PARAM AIOTG  0.0201;      ?  0.0151 (old);
PARAM AIOTB  0.143908;      ?  0.1411 (old);
PARAM AIOTM  0.143908;      ?  0.1864 (old);

PARAM AIOMSC  0.471463;      ?  0.3886 (old);
PARAM AIOMSG  0.116184;      ?  0.07 (old);
PARAM AIOMSB  0.420179;      ?  0.5061 (old);
PARAM AIOMSM  0.420179;      ?  0.4316 (old);

GEW=YWG;
RGENW=GENW/PG;

FDOT=AIOTC*CONS+AIOTG*RGENW+AIOTB*(IBCTOT+IH)+AIOTM*IMETOT;

FDOMS=AIOMSC*CONS+AIOMSG*RGENW+AIOMSB*(IBCTOT+IH)+AIOMSM*IMETOT;

print FDOT, FDOMS;

? -----
? -----  Government revenue and expenditure data  -----
? -----

? -----
? Public expenditure data categories
? -----

? EXTRACT: Subsidies on products (GSUBPD) and total subsidies (GSUBTOT)

GSUBPD=GSUBPD;
GSUBTOT=GSUBTOT;

```

```
? Derive residual class of subsidies (GSUBO)

GSUBO=GSUBTOT-GSUBPD;

GSUB=GSUBPD+GSUBO;
RGSUB=GSUB/GDPFCV;

? Derive subsidy rates

RGSUBPD=GSUBPD/GDPFCV;
RGSUBO=GSUBO/GDPFCV;

print GSUBPD, GSRUBPD, GSUBO, GSUBTOT, RGSUBPD, RGSUBO;

? Construction of total transfer payments

? EXTRACT: GTRCURRE : Current Transfer payments
? to nonprofit institutions, households and abroad

GTRCURRE=GTRCURRE;

? EXTRACT: National Debt Interest Payments

GTRND=GTRND;

? Derive total transfers

GTR= GTRCURRE + GTRND;

? EXTRACT: Transfers abroad (GTRABR, zero) and Unemployment Transfers (GTRU)

GTRABR=GTRABR;
GTRU=GTRU;

RGTRU=GTRU/U;

? Replacement ratio (REPR)

REPR=RGTRU/WT;
print RGTRU, WT, REPR;

? Derive (as residual) social welfare transfers (GTRSW)

GTRSW=GTR-GTRU-GTRABR-GTRND;
RGTRSW=GTRSW/(PCONS*N);

? Total current public expenditure (GEC)

? EXTRACT: GFS version of GV (GVG)

GVG=GVG;

GV_DIF=GVG-GV;
print GV, GVG, GV_DIF;

GEC=(GV+GV_DIF)+(GSUBPD+GSUBO)+GTR;
print GEC;

? EXTRACT: Government Capital Transfers (including Net Lending)

GTRK=GTRK;
RGTRK=GTRK/ITV;
```

```

print GTRK, ITV, RGTRK;

? EXTRACT: Government Capital Revenue

GREVK=GREVK;

? Define total capital expenditure

GEK = IHGV+ (IGV+ISMV) + GTRK ;

? EXTRACT: GFS version of GEK (GEKG)

GEKG=GEKG;
GEK_DIF=GEKG-GEK;
print GEK, GEKG, GEK_DIF;

? Total public expenditure (current plus capital)

GEXP=GEC+GEK;

? -----
? Tax and other government revenue data
? -----

YWNA=YWT+YWBC+YWMS+YWG;
YW=YWNA+YWA;

? EXTRACT: Indirect taxes (nominal) on production (GTEPD)
? and indirect taxes on production plus imports (GTEPDM)

GTEPD=GTEPD;
GTEPDM=GTEPDM;

? Customs duties (GTEM)

GTEM=GTEPDM-GTEPD;

GTE=GTEPD+GTEM;

RGTEPD=GTEPD/CONSV;
RGTEM=GTEM/GDPFCV;
print RGTEPD, RGTEM;

? EXTRACT: Total taxes on income (GTYTOT)

GTYTOT=GTYTOT;

? EXTRACT: Taxes on property (GTYPROP)

GTYPROP=GTYPROP;

? EXTRACT: Corporation tax (GTYC) (subset of GTYTOT)

GTYC=GTYC;

? EXTRACT: Total social security contributions (GTYSOC)

GTYSOC=GTYSOC;

? EXTRACT: Employers' social security contributions (GTYSOCE)

GTYSOCE=GTYSOCE;

```

```

? Calculate employees' soc. insurance contributions residually
GTYSOCW=GTYSOC-GTYSOCE;

? Define personal direct tax revenue (GTYP)
GTYP=GTYTOT-GTYC;

? redefine total taxes on income (GTY)
GTY=GTYP+GTYC+GTYSOC;

? EXTRACT: Other revenue
GREVO=GREVO;

? EXTRACT: Revenue from abroad (GREVABR)
GREVABR=GREVABR;

GREVDOM=GREVO-GREVABR;

RGREVO=GREVO/GDPFCV;

? Check if the gross wage bill (YW) is the income tax base
RGTYP=GTYP/YW;
RGTYPEX=RGTYP;
RGTYSOCW=GTYSOCW/YW;
RGTYSOCE=GTYSOCE/YW;
print RGTYP, RGTYSOCW, RGTYSOCE;

? EXTRACT: Total current revenue (GREVC)
GREVC=GREVC;

? Derive DIFGREVC residually
DIFGREVC = GREVC - ((GTEPD+GTEM) + (GTYP+GTYC) + GTYSOC + GTYPROP + GREVO);
print GREVC, DIFGREVC;

? Total revenue (GREV)
GREV = GREVC + GREVK;

print GREVC, GREV ;

? -----
? Define CZECH public sector borrowing requirement
? Current (GBORC) and total (GBOR)
? -----

? Current PSBR (GBORC)
GBORC = (GEC - GREVC);

? Total PSBR (GBOR)
GBOR = GEXP - GREV;

? Extract privatisation revenues (GREVPRIV)

```

```

GREVPRIV=GREVPRIV;

? The IMF version of the PSBR (GBORIMF)

GBORIMF = GBOR - GREVPRIV;
print GBORC, GBOR, GBORIMF;

? EXTRACT: Total national debt (GND)

GND=GND;

? Define implicit national debt interest rate (RGDI)

RGDI=100*GTRND/((GND+GND(-1))/2);
print RGDI, RNL, RNS, RNG;

? Set exogenous version of national debt (GNDTG), and a target
? national debt (GNDTG) for future use in policy feed-back rule

GNDEX=GND;
GNDTG=GND;
print GND;

DUMGND=1;

RGND=100*GTRND/GND;
print RGND, RNS, RNL, RNG;

? -----
? Construction of GDP at market prices
? Input data: GTRE, YFN, DEP, GTTI
? -----

? EXTRACT: Constant price indirect taxes (GTRE) and subsidies (GSRUB).

GTREPD = GTREPD;
RGTREPD=GTREPD/CONS;
PGTEPD=GTREPD/GTREPD;

GSRUBPD=GSRUBPD;
RGSUBPD=GSRUBPD/GDPFC;
PGSUBPD=GSRUBPD/GSRUBPD;

GDPMV = GDPFCV+(GTEPD-GSUBPD);
GDPM = GDPFC+(GTREPD-GSRUBPD);

? Check differences between GDPE and GDPM

DIFGDPE=GDPE-GDPM;
DIFGDPEV=GDPEV-GDPMV;
print GDPEV, GDPMV, DIFGDPEV;
print GDPE, GDPM, DIFGDPE;

GDPMDOT = 100*(GDPM/GDPM(-1)-1);
PGDPM = GDPMV/GDPM;
PGDPMDOT = 100*(PGDPM/PGDPM(-1)-1);

print GDPMDOT, PGDPMDOT;

? Define overall public expenditure (GETOTRAT) and tax (GRTOTRAT) ratios

```



```

GETOTRAT=100*GEXP/GDPMV;
GRTOTRAT=100*GREV/GDPMV;

? Investment ratios

IRGDP = 100*IV/GDPEV;

RIGV=IGV/GDPEV;
RISMGV=ISMGV/GDPEV;

? Derive output-expenditure statistical discrepancy (STATDISV, STATDIS)

STATDISV=GDPEV-GDPMV;
STATDIS=GDPE-GDPM;

RGDPEV=GDPEV/GDPMV;
print STATDIS, STATDISV, RGDPEV;

RSDIS=100*STATDIS/GDPE;
RSDISV=100*STATDISV/GDPEV;
print RSDIS, RSDISV;

? EXTRACT: Net factor income from abroad

YFN=YFN;

YFN RAT=100*YFN/GDPMV;
YFNPO=0.0;
GTRNF=0.0;
print YFN, YFN RAT;

? Deflate YFN using GDPE deflator (PGDPE)

PYFN=PGDPE;

YRFN=YFN/PYFN;

? Derive gross national product (GNPV, GNP)

GNPV=GDPMV+YFN;
GNP=GDPM+YRFN;
PGNP=GNPV/GNP;
PGNPDOT=100*(GNP/GNP(-1)-1);
GNPDOT=100*(GNP/GNP(-1)-1);
GNPPC=GNP/N;
print GNPV, GNP, GNP DOT, PGNP, PGNPDOT, GNPPC;

? DEP (current prices) is calculated from sectoral ones

DEP=PIA*DEPA+PIT*DEPT+PIBC*DEPBC+PIMS*DEPMS+PIG*DEPG;
DEPRATE=100*DEP/GDPFCV;
print DEP, DEPRATE;

DEPRAT=DEP/(PI*(KT+KBC+KMS+KA+KGINF));
print DEP, DEPRAT;

? -----
? Derivation of personal disposable income (YPERD)
? -----

? Net domestic product at factor cost (NDPFCV)

```

```

NDPFCV = GDPMV-DEP-(GTEPD-GSUBPD);
? EXTRACT: YASA (set to zero)
YASA=YASA;
? Net national product at factor cost (NNPFCV)
NNPFCV=NDPFCV+YFN+YASA;
? EXTRACT: GTTI (public sector trading and investment income)
GTTI=GTTI;
? EXTRACT: BTPRNE
BTPRNE=BTPRNE;
? Private income (YP)
YP=NNPFCV-GTTI+GTR+BTPRNE;
? Aggregate rate of personal (non-corporate) taxation (RGTY)
YC=NDPFCV-YW+YASA+YAFS;
YCRAT=100*YC/GDPFCV;
print YCRAT;
RGTYC=GTTC/YC(-1);
print YC, RGTYC;
? EXTRACT: Undistributed profits (YCU)
YCU=YCU;
YCURAT=YCU/YC;
print YC, YCU, YCURAT;
? Personal income (YPER)
YPER=YP-YCU;
? Define personal disposable income by netting off direct tax paid
? by the personal (non-corporate) sector (GTYP+GTYSOCW).
YPERD=YPER-(GTYP+GTYSOCW);
YRPERD=YPERD/PCONS;
YRPERDPC=YRPERD/N;
? Household savings (SAV)
SAV=YPERD-CONSV;
? Household savings rate (SAVRAT)
SAVRAT=100*SAV/YPERD;
print SAV, SAVRAT;
WNA=YWNA/(LTEMP+LBCOMP+LMSEMP+LG);
WNADOT=100*(WNA/WNA(-1)-1);

```

```

LPROD=GDPPFC/L;
LPRODDOT=100*(LPROD/LPROD(-1)-1);

ONA=OT+OBC+OMS+OG;

OPNA=OT+OBC+OMS;
POPNA=(OTV+OBCV+OMSV)/(OT+OBC+OMS);
POPNADOT=100*(POPNA/POPNA(-1)-1);
YWPNA=YWT+YWBC+YWMS;
WPNA=(YWT+YWBC+YWMS)/(LTEMP+LBCEMP+LMSEMP);
RWPNA=WPNA/PCONS;
RWPNADOT=100*(RWPNA/RWPNA(-1)-1);
LPRPNA=(OT+OBC+OMS)/(LT+LBC+LMS);
ULCPNA=(YWT+YWBC+YWMS)/(OT+OBC+OMS);

TINC=(RGTEPD+RGTEM)-(RGSUBPD+RGSUBO);

? Tax wedge (WEDGE)
WEDGE=(1+RGTYT+RGTYSOCE+RGTYSOCW)*(1+RGTEPD+RGTEM);

? Real after tax wage in manufacturing (RATWT)
RATWT=WT*(1-RGTYT-RGTYSOCW)/PCONS;

print TINC, WEDGE;

? EXTRACT: BPTCK
BPTCK=BPTCK;

? Current account of balance of payments (BP)
BP = NTSV + YFN+BPTPRNE+GREVABR-GTRABR+BPTCK;
BPRES = BP - (NTSV+YFN);

BPR=100*BP/GDPEV;
NTSVR=100*(NTSV/GDPEV);
GBORCR=100*(GBOR/GDPEV);
GBORR=100*GBOR/GDPEV;
GBORIMFR=100*(GBORIMF/GDPEV);

print BP, NTSV, GBOR, GBORIMF, GDPEV;
print BPR, NTSVR, GBORR, GBORIMFR;;

? Debt/GDP ratio (RDEBT)
RDEBT=100*(GND/GDPEV);
print RDEBT;

? Miscellaneous generations
KIHP=IHP/GDPE;
print IHP, GDPE, KIHP;

? The primary borrowing requirement (GBORP) nets out interest payments
? on the national debt (GTRND) from GBOR.
GBORP=(GEC-GTRND-GREVC)+(GEK-GREVK) ;

```

? GBORPR is the primary public sector borrowing requirement (GBORP) expressed  
? as a percentage of GNP.

GBORPR=100\*GBORP/GDPEV;

? -----  
? Add in the CSF variables as zero for the present  
? -----

DETAMSPH=0.0;  
DETAMSPI=0.0;

DETATPH=0.0;  
DETATPI=0.0;

DETATQH=0.0;  
DETATQI=0.0;

GTRSFDP=0.0;  
GTRSFEC=0.0;  
GTRSFPR=0.0;

IGVCSFDP=0.0;  
IGVCSFEC=0.0;  
IGVCSFPR=0.0;

LOCDP=0.0;  
LOCEC=0.0;  
LOCPR=0.0;

GTRSFDP\_E=0.0;  
GTRSFEC\_E=0.0;  
GTRSFPR\_E=0.0;

IGVCSFDP\_E=0.0;  
IGVCSFEC\_E=0.0;  
IGVCSFPR\_E=0.0;

LOCDP\_E=0.0;  
LOCEC\_E=0.0;  
LOCPR\_E=0.0;

TFRACT=0.0;

TRIADP=0.0;  
TRIAEC=0.0;  
TRIAPR=0.0;

TRIMSDP=0.0;  
TRIMSEC=0.0;  
TRIMSFR=0.0;

TRITDP=0.0;  
TRITEC=0.0;  
TRITPR=0.0;

TRIADP\_E=0.0;  
TRIAEC\_E=0.0;  
TRIAPR\_E=0.0;

TRIMSDP\_E=0.0;  
TRIMSEC\_E=0.0;

```
TRIMSPR_E=0.0;

TRITDP_E=0.0;
TRITEC_E=0.0;
TRITPR_E=0.0;

TRIMS=0.0;
TRIMSEOT=0.0;
TRIT=0.0;
TRITEOT=0.0;
TRIA=0.0;
TRIAEOT=0.0;

CSFTRAN=0.0;
CSFTRANR=0.0;

GECSFRA0=0.0;
GECSFRA1=0.0;
GECSFRA2=0.0;
GECSFRA3=0.0;
GECSF4=0.0;
GECSF5=0.0;
GECSF6=0.0;
GECSF7=0.0;
GECSF8=0.0;
GECSF9=0.0;
GECSF10=0.0;
GECSF11=0.0;
GECSF12=0.0;
GECSF13=0.0;
GECSF14=0.0;
GECSF15=0.0;
GECSF16=0.0;
GECSF17=0.0;
GECSF18=0.0;
GECSF19=0.0;
GECSF20=0.0;
GECSF21=0.0;
GECSF22=0.0;
GECSF23=0.0;
GECSF24=0.0;
GECSF25=0.0;
GECSF26=0.0;
GECSF27=0.0;
GECSF28=0.0;
GECSF29=0.0;
GECSF30=0.0;
GECSF31=0.0;
GECSF32=0.0;
GECSF33=0.0;
GECSF34=0.0;
GECSF35=0.0;
GECSF36=0.0;
GECSF37=0.0;
GECSF38=0.0;
GECSF39=0.0;
GECSF40=0.0;
GECSF41=0.0;
GECSF42=0.0;
GECSF43=0.0;
GECSF44=0.0;
GECSF45=0.0;
GECSF46=0.0;
GECSF47=0.0;
GECSF48=0.0;
GECSF49=0.0;
GECSF50=0.0;
GECSF51=0.0;
GECSF52=0.0;
GECSF53=0.0;
GECSF54=0.0;
GECSF55=0.0;
GECSF56=0.0;
GECSF57=0.0;
GECSF58=0.0;
GECSF59=0.0;
GECSF60=0.0;
GECSF61=0.0;
GECSF62=0.0;
GECSF63=0.0;
GECSF64=0.0;
GECSF65=0.0;
GECSF66=0.0;
GECSF67=0.0;
GECSF68=0.0;
GECSF69=0.0;
GECSF70=0.0;
GECSF71=0.0;
GECSF72=0.0;
GECSF73=0.0;
GECSF74=0.0;
GECSF75=0.0;
GECSF76=0.0;
GECSF77=0.0;
GECSF78=0.0;
GECSF79=0.0;
GECSF80=0.0;
GECSF81=0.0;
GECSF82=0.0;
GECSF83=0.0;
GECSF84=0.0;
GECSF85=0.0;
GECSF86=0.0;
GECSF87=0.0;
GECSF88=0.0;
GECSF89=0.0;
GECSF90=0.0;
GECSF91=0.0;
GECSF92=0.0;
GECSF93=0.0;
GECSF94=0.0;
GECSF95=0.0;
GECSF96=0.0;
GECSF97=0.0;
GECSF98=0.0;
GECSF99=0.0;
GECSF100=0.0;

GECSF=0;
GECSFDP=0;
GECSFE=0;
GECSFEC=0;
GECSFEC_E=0;
GECSFEP=0;
GECSFRAE=0;
GECSFRAPE=0;

TRIDP=0.0;
TRIEC=0.0;

GTRSF=0.0;

IGVCSF=0.0;

KSFTRAIN=0.0;
KTRAIN=(9*0.55*0.0 + 3*0.27*1.0 + 3*0.06*1.0 + 11*0.12*1.0)*LF;
KTRAIN0=KTRAIN;
KTRNR=1.0;

KT0=KT;
KTR=KT/KT0;
KMS0=KMS;
KMSR=KMS/KMS0;

LINS=0.0;
SFTRAIN=0.0;
SFWAG=0.0;

WTRAIN=0.3*WT;

KGINF0=KGINF;
KGINFR=KGINF/KGINF0;
GDPEV0=GDPEV;

CSFTRNEC=0.0;
```

```

CSFTRNDP=0.0;
CSFECDR=0.0;
CSFDPR=0.0;
GTRTOT=GTR;
GTRF=0.0;

GECSFEC_RE = 0.0;
RDCOFIN = 0.0;
RIGVCSF = 0.0;
RGTRSF = 0.0;
RTRIT = 0.0;
RTRIMS = 0.0;

GEKCSF=0.0 ;

? -----
? Set ANX and ANT to the calibrated AN and AT CES parameters
? -----

ATX = 30.72720;
AMXS = 20.85560;

END;

```

## C.2: ASSEMBLING THE NEW (HCZ5) HERMIN MODEL DATABASE

### C.2.1: HCZ5EXOG.TSP: THE EXOGENOUS VARIABLES

```

? -----
? TSP batch file to transfer first part of model historical data
? to a WINSOLVE-readable XLS file (HCZ5EXOG1.XLS)

?           Last modified: April 8, 2006
? -----

IN HCZ5DB ;

FREQ A;
SMPL 1995,2004;

WRITE(FILE='C:\SIM\HCZ5\HCZ5EXOG.XLS')
BGIP, BGP, BPRES, BPTPNE, CZKGBF, CZKDM, CZKESP, CZKFRF, CZKGBP,
CZKILI, CZKNLG, CZKSEK, CZKUSD, DEPARAT, DEPBBCRAT, DEPGRAT, DEPMSRAT,
DEPTRAT, DEPRAT, DETAMSPI, DETAMSPH, DETATPH, DETATPI, DETATQH, DETATQI,
DIFGDPE, DIFGDPEV, DIFGREVC,
DKIP, FNIP, FRIP, FRP, GECSFEC_RE, GEIP, GEP, GREVK, GTRABR, GTRSFPR,
GTTI, GTYPROP, GV_DIF, HUIP, IGV, IGVCSFPR, IHGV, ISMGV, ITIP, ITP, KIHP,
KYCTREP, LG, LOCDP, LOCEC, LOCPR, MW1, MW2, MW3, MW4, MW5, MW6, MW7, MW8,
MW9, N, NELD, NLIP, NLP, NWIP, NWORK, OEIP, OGNW, POA, PTIP,
RDCOFIN, RGDI, RGENW, RGREVO, RGSUBPD, RGSUBO, RGSUBPD, RGTEM, RGTEPD,
RGTREPD, RGTRK, RGTRSF, RGTRSW, RGTYC, RGTYP, RGTYSOCE, RGTYSOCW,
RIGVCSF, RRSR, RTRIT, RUIP, SDIP, SDP, SEARAT, SEBCRAT, SEMSRAT, SETRAT,
SPIP, SPP, STDISE, STDISI, STDISIV, SWIP, T, TBC, TFRAC, TKA, TLA, TLFPR,
TMS, TOA, TOBC, TOMS, TOT,

```

TRIADP, TRIAEC, TRIAPR, TRIMSPP, TRITPR, TT, TYAFS, UKIP, UKP, USIP, USP,  
WIGME, WIOME, XW1, XW2, XW3, XW4, XW5, XW6, XW7, XW8, XW9, XWBG, XWDK,  
XWFN, XWFR, XWGE, XWHU, XWIT, XWNL, XWNW, XWOE, XWPT, XWRU, XWSD, XWSP,  
XWSW, XWUK, XWUS, YASA, YCURAT, YFN  
;  
  
END;

### C.2.2: HCZ5ENDOG1.TSP: THE ENDOGENOUS VARIABLES (PART 1)

```
? -----
? TSP batch file to transfer first part of model historical data
? (endogenous) to a WINSOLVE-readable XLS file (HCZ5ENDO1.XLS)

?           Last modified: April 8, 2006
? -----

IN HCZ5DB ;

FREQ A;
SMPL 1995,2004;

WRITE(FILE='C:\SIM\HCZ5\HCZ5ENDO1.XLS')
AMSX, ATX, BP, BPR, CONS CONSV, CSFTRAN, CSFTRANR, DEP, DS, DSV,
ERFPBC, ERFPMS, ERFPPT, FDOMS, FDOT, G, GBOR, GBORP, GBORPR, GBORR,
GDPE, GDPEV, GDPEV0, GDPFCV, GDPFCV, GDPM, GDPMV, GEC, GECSF,
GECSFDP, GECSFE, GECSFEC, GECSFEC_E, GECSFDP, GECSFRAE, GECSFRAP,
GECSFRAT, GECSFT, GECSFTR, GEK, GEKCSF, GENW, GEW, GEXP, GND, GNP,
GNPDOT, GNPPC, GNPV, GREV, GREVC, GREVO, GSRUBPD, GSUB, GSUBO, GSUBPD,
GTE, GTEM, GTEPD, GTR, GTREPD, GTRK, GTRND, GTRSF, GTRSFDP, GTRSFEC,
GTRSW, GTRU, GTY, GTYC, GTYP, GTYSOC, GTYSOCE, GTYSOCW, GV, I, IA, IAV,
IBC, IBCTOT, IBCV, IG, IGINF, IGINFBC, IGINFME, IGINFV, IGVCSE, IGVCSEFDP,
IGVCSEFEC, IH, IHG, IHP, IHV, IMETOT, IMS, IMSV, INH, IOTH, IOTHBC, IOTHME,
IT, ITV, IV, KA, KBC, KGINF, KGINF0, KGINFR, KMS, KMS0, KMSR, KSFTRAIN,
KT, KT0, KTR, KTRAIN, KTRAIN0, KTRNR
;

END;
```

### C.2.3: HCZ5ENDOG2.TSP: THE ENDOGENOUS VARIABLES (PART 2)

```
? -----
? TSP batch file to transfer second part of model historical data
? (endogenous) to a WINSOLVE-readable XLS file (HCZ5ENDO1.XLS)

?           Last modified: April 8, 2006
? -----

IN HCZ5DB ;

FREQ A;
SMPL 1995,2004;

WRITE(FILE='C:\SIM\HCZ5\HCZ5ENDO2.XLS')
L, LA, LAEMP, LASEMP, LBC, LBCEMP,
LBCSEMP, LF, LFPR, LINS, LMS, LMSEMP, LMSSEMP, LNA, LPRBC, LPRMS, LPROD,
LPRT, LSHRA, LSHRBC, LSHRMS, LSHRT, LT, LTEMP, LTSEMP, NDFPCV, NJUV,
NNPFCV, NTS, NTSV, NTSVR, OA, OAV, OBC, OBCV, OG, OGNWV, OGV, OMS, OMSV,
OT, OTV, OW, PBG, PCOMPT, PCONS, PCONSDOT, PDS, PFR, PG, PGDPE, PGDFPC,
PGDPM, PGE, PGNP, PI, PIA, PIBC, PIG, PIH, PIMS, PIT, PITA, PKBC, PKMS,
PKT, PM, PNL, POBC, POG, POMS, POT, PSD, PSP, PUK, PUS, PWORLD, PYAFS,
PYFN, RATWT, RDEBT, REPR, RFPBC, RFPMS, RFPT, RGSUB, RGTRU, RULCT,
```



---

SAV, SAVRAT, SFTRAIN, SFWAG, ST, TINC, TRIA, TRIAEOT, TRIDP, TRIEC, TRIMS,  
TRIMSDP, TRIMSEC, TRIMSEOT, TRIT, TRITDP, TRITEC, TRITEOT, U, ULCBC, ULCMS,  
ULCT, UR, URBAR, URP, WA, WBC, WBCDOT, WEDGE, WG, WMS, WMSDOT, WNA, WNADOT,  
WT, WTDOT, WTRAIN, YAFS, YC, YCA, YCBC, YCMS, YCT, YCTREP, YCU, YP, YPER,  
YPERD, YRAFS, YRFN, YRPERD, YRPERDPC, YW, YWA, YWBC, YWG, YWMS, YWNA,  
YWT  
;  
  
END;

# D

## A DICTIONARY OF THE HCZ5 MODEL VARIABLES

### D.1 THE EXOGENOUS VARIABLES OF HCZ5

Number	Notation	Description
1	BGIP	Industrial output: (index) Belgium
2	BGP	Industrial output price: Belgium (index)
3	BPRES	BOP item: residual
4	BTPRNE	BOP item: private transfers
5	CZKBGF	Czech-Belgian exchange rate
6	CZKDM	Czech-German exchange rate
7	CZKESP	Czech-Spanish exchange rate
8	CZKFRF	Czech-French exchange rate
9	CZKGBP	Czech-British exchange rate
10	CZKILI	Czech-Italian exchange rate
11	CZKNLG	Czech-Dutch exchange rate
12	CZKSEK	Czech-Swedish exchange rate
13	CZKUSD	Czech-US exchange rate
14	DEPARAT	Depreciation rate: Agriculture
15	DEPBCRAT	Depreciation rate: Building/Construction
16	DEPGRAT	Depreciation rate: Public Sector
17	DEPMSRAT	Depreciation rate: Market Services
18	DEPTRAT	Depreciation rate: Manufacturing
19	DEPRAT	Depreciation rate: Total economy-wide
20	DETAMSPI	NSRF phase-in parameter: Market Services/infrastructure
21	DETAMSPH	NSRF phase-in parameter: Market Services/human resources
22	DETATPH	NSRF phase-in parameter: Manufacturing/human resources
23	DETATPI	NSRF phase-in parameter: Manufacturing/infrastructure
24	DETATQH	NSRF phase-in parameter: Manufacturing/human resources/output
25	DETATQI	NSRF phase-in parameter: Manufacturing/infrastructure/output
26	DIFGDPE	Statistical discrepancy/GDPE
27	DIFGDPEV	Statistical discrepancy/GDPEV

28	DIFGREVC	Statistical discrepancy/GREVC
29	DKIP	Industrial output: (index) Denmark
30	FNIP	Industrial output: (index) Finland
31	FRIP	Industrial output: (index) France
32	FRP	Industrial output price: France (index)
33	GECSFEC_RE	Real EC NSRF financial injection/total
34	GEIP	Industrial output: (index) Germany
35	GEP	Industrial output price: Germany (index)
36	GREVK	Capital revenue
37	GTRABR	Public transfers abroad
38	GTRSFPR	EC ESF contribution/private
39	GTTI	Government trading & investment income
40	GTYPROP	Income tax revenue: property
41	GV_DIF	Statistical discrepancy/GV
42	HUIP	Industrial output: (index) Hungary
43	IGV	Public investment: current
44	IGVCSFPR	EC infrastructure contribution/private
45	IHGV	Public housing investment: current
46	ISMGV	Public investment for government sector executed by private sector: current
47	ITIP	Industrial output: (index) Italy
48	ITP	Industrial output price: Italy (index)
49	KIHP	Ratio of IHP to GDPE
50	KYCTREP	Ratio of YCTREP to YCT
51	LG	Public employment: thousands
52	LOCDP	EC NESF regional investment item: domestic public
53	LOCEC	EC NESF regional investment item: EC contribution
54	LOCPR	EC NESF regional investment item: domestic private
55	MW1	Import share weight (see HERDATA_HCZ5.TSP for definition)
56	MW2	Import share weight (see HERDATA_HCZ5.TSP for definition)
57	MW3	Import share weight (see HERDATA_HCZ5.TSP for definition)
58	MW4	Import share weight (see HERDATA_HCZ5.TSP for definition)
59	MW5	Import share weight (see HERDATA_HCZ5.TSP for definition)
60	MW6	Import share weight (see HERDATA_HCZ5.TSP for definition)
61	MW7	Import share weight (see HERDATA_HCZ5.TSP for definition)
62	MW8	Import share weight (see HERDATA_HCZ5.TSP for definition)
63	MW9	Import share weight (see HERDATA_HCZ5.TSP for definition)

64	N	Total population: thousands
65	NELD	Retired population: thousands
66	NLIP	Industrial output: (index) Netherlands
67	NLP	Industrial output price: Netherlands (index)
68	NWIP	Industrial output: (index) Norway
69	NWORK	Working age population: thousands
70	OEIP	Industrial output: (index) Austria
71	OGNW	Non-wage public sector output: real
72	POA	Deflator of OAV
73	PTIP	Industrial output: (index) Portugal
74	RDCOFIN	Domestic co-finance ratio in NSRF
75	RGDI	Implicit rate of national debt interest
76	RGENW	Non-wage public consumption: real
77	RGREVO	Implicit rate of other revenue
78	RGSUBPD	Implicit rate of production-related subsidies: real
79	RGSUBO	Implicit rate of other subsidies
80	RGSUBPD	Implicit rate of production-related subsidies: real
81	RGTEM	Implicit rate of import duties
82	RGTEPD	Implicit rate of production-related taxes
83	RGTREPD	Implicit rate of production-related taxes: real
84	RGTRK	Implicit rate of capital transfers
85	RGTRSF	Fraction of NSRF spent of ESF human resource area
86	RGTRSW	Implicit rate of social insurance payments
87	RGTYC	Implicit rate of corporate taxation
88	RGTYP	Implicit rate of personal income tax
89	RGTYSOCE	Implicit rate of social insurance contributions: employers
90	RGTYSOCW	Implicit rate of social insurance contributions: employees
91	RIGVCSF	Fraction of NSRF spent of physical infrastructure area
92	RRSA	Exogenous real rate of return on investment (assumed to be fixed at 8%)
93	RTRIT	Fraction of NSRF direct aid to productive sector spent on direct aid to manufacturing
94	RUIP	Industrial output: (index) Russia
95	SDIP	Industrial output: (index) Sweden
96	SDP	Industrial output price: Sweden (index)
97	SEARAT	Fraction of self-employment: agriculture
98	SEBCRAT	Fraction of self-employment: building/construction
99	SEMSRAT	Fraction of self-employment: market services

100	SETRAT	Fraction of self-employment: manufacturing
101	SPIP	Industrial output: (index) Spain
102	SPP	Industrial output price: Spain (index)
103	STDISE	Statistical discrepancy: GDPE
104	STDISI	Statistical discrepancy: I
105	STDISIV	Statistical discrepancy: IV
106	SWIP	Industrial output: (index) Switzerland
107	T	Time index
108	TBC	Time index: HNTF building/construction
109	TFRACT	Fraction of ESF trainees taken from labour force
110	TKA	Time trend index: KA
111	TLA	Time trend index: LA
112	TLFPR	Time trend index: LFPR
113	TMS	Time index: HNTF market services
114	TOA	Time trend index: OA
115	TOBC	Time trend index: OBC
116	TOMS	Time trend index: OMS
117	TOT	Time trend index: OT
118	TRIADP	Direct NSRF aid to agriculture: domestic public
119	TRIAEC	Direct NSRF aid to agriculture: EC
120	TRIAPR	Direct NSRF aid to agriculture: domestic private
121	TRIMSPR	Direct NSRF aid to market services: domestic private
122	TRITPR	Direct NSRF aid to manufacturing: domestic private
123	TT	Time index: HNTF manufacturing
124	TYAFS	Time trend index: YAFS
125	UKIP	Industrial output: (index) UK
126	UKP	Industrial output price: UK (index)
127	USIP	Industrial output: (index) US
128	USP	Industrial output price: US (index)
129	WIGME	Fraction of total public investment consisting of machinery & equipment
130	WIOME	Fraction of total private investment consisting of machinery & equipment
131	XW1	Export share weight (see HERDATA_HCZ5.TSP for definition)
132	XW2	Export share weight (see HERDATA_HCZ5.TSP for definition)
133	XW3	Export share weight (see HERDATA_HCZ5.TSP for definition)
134	XW4	Export share weight (see HERDATA_HCZ5.TSP for definition)

135	XW5	Export share weight (see HERDATA_HCZ5.TSP for definition)
136	XW6	Export share weight (see HERDATA_HCZ5.TSP for definition)
137	XW7	Export share weight (see HERDATA_HCZ5.TSP for definition)
138	XW8	Export share weight (see HERDATA_HCZ5.TSP for definition)
139	XW9	Export share weight (see HERDATA_HCZ5.TSP for definition)
140	XWBG	Export share: Belgium
141	XWDK	Export share: Denmark
142	XWFN	Export share: Finland
143	XWFR	Export share: France
144	XWGE	Export share: Germany
145	XWHU	Export share: Hungary
146	XWIT	Export share: Italy
147	XWNL	Export share: Netherlands
148	XWNW	Export share: Norway
149	XWOE	Export share: Austria
150	XWPT	Export share: Portugal
151	XWRU	Export share: Russia
152	XWSD	Export share: Sweden
153	XWSP	Export share: Spain
154	XWSW	Export share: Switzerland
155	XWUK	Export share: UK
156	XWUS	Export share: US
157	YASA	Adjustment for stock appreciation
158	YCURAT	Retained profits
159	YFN	BOP item: Net factor income from abroad

**D.2: THE ENDOGENOUS VARIABLES OF HCZ5**

<b>Number</b>	<b>Notation</b>	<b>Description</b>
1	AM SX	Scale parameter in market services CES production function
2	ATX	Scale parameter in manufacturing CES production function
3	BP	BOP: current account balance
4	BPR	BOP: current account balance as percentage of GDP
5	CONS	Private consumption: real
6	CONSV	Private consumption: value
7	CSFTRAN	Total NSRF financial transfers
8	CSFTRANR	Total NSRF financial transfers as percentage of GDPEV
9	DEP	Total depreciation: value
10	DS	Stock changes: real
11	DSV	Stock changes: value
12	ERFPBC	MA of RFPBC
13	ERFPMS	MA of RFPMS
14	ERFPT	MA of RFPT
15	FDOMS	OMS-weighted final demand
16	FDOT	OT-weighted final demand
17	G	Public consumption: real
18	GBOR	Public sector borrowing requirement
19	GBORP	Primary public sector borrowing requirement
20	GBORPR	Primary public sector borrowing requirement as percent of GDP
21	GBORR	Public sector borrowing requirement as percent of GDP
22	GDPE	GDP on expenditure basis: real
23	GDPEV	GDP on expenditure basis: value
24	GDPEV0	Base (without-NSRF) GDP on expenditure basis: value
25	GDPFC	GDP at factor cost: real
26	GDPFCV	GDP at factor cost: value
27	GDPM	GDP at market prices: real
28	GDPMV	GDP at market prices: value
29	GEC	Total public current expenditure
30	GECSF	Total NSRF expenditure
31	GECSFDP	NSRF expenditure: domestic public
32	GECSFE	NSRF expenditure

33	GECSFEC	NSRF expenditure: EC
34	GECSFEC_E	NSRF expenditure: EC (euro)
35	GECSFRAE	NSRF expenditure: EC (fraction of GDP)
36	GECSFRAP	NSRF expenditure: Domestic public (fraction of GDP)
37	GECSFRAT	NSRF expenditure: total (fraction of GDP)
38	GECSFT	Total NSRF expenditure
39	GECSFTR	Total NSRF expenditure: real
40	GEK	Total public capital expenditure
41	GEKCSF	Total public capital expenditure: NSRF-related
42	GENW	Public consumption/non-wage: value
43	GEW	Public consumption/wage: value
44	GEXP	Total public expenditure
45	GND	Stock of public debt
46	GNP	Gross national product: real
47	GNPDOT	Rate of change of GNP: percent
48	GNPPC	Per-capita GNP
49	GNPV	Gross national product: value
50	GREV	Total government revenue
51	GREVC	Total current government revenue
52	GREVO	Government revenue: "other" category
53	GSRUBPD	Production-related subsidies: real
54	GSUB	Total subsidies
55	GSUBO	Subsidies: "other" category
56	GSUBPD	Production-related subsidies: value
57	GTE	Total indirect tax revenue
58	GTEM	Revenue from import duties
59	GTEPD	Indirect production-related tax revenue
60	GTR	Total public sector transfers
61	GTRFPD	Indirect production-related tax revenue: real
62	GTRK	Total capital transfers
63	GTRND	Transfers expenditure: national debt interest
64	GTRSF	ESF transfers
65	GTRSFDP	ESF transfers domestic public
66	GTRSFEC	ESF transfers: EC
67	GTRSW	Transfers expenditure: social welfare payments
68	GTRU	Transfers expenditure: unemployment income support payments
69	GTY	Total direct tax revenue
70	GTYC	Revenue from corporation taxes



71	GTYP	Revenue from personal income taxes
72	GTYSOC	Total social insurance contributions
73	GTYSOCE	Social insurance contributions: employers
74	GTYSOCW	Social insurance contributions: employees
75	GV	Public consumption: value
76	I	Total investment: real
77	IA	Investment: agriculture: real
78	IAV	Investment: agriculture: value
79	IBC	Investment: building/construction: real
80	IBCTOT	Investment by type of good: building/construction: real
81	IBCV	Investment: building/construction: value
82	IG	Investment: public sector: real
83	IGINF	Investment: infrastructure: real
84	IGINFBC	Investment: infrastructure: B&C goods: real
85	IGINFME	Investment: infrastructure: M&E goods: real
86	IGINFV	Investment: infrastructure: value
87	IGVCSF	Investment: NSRF-related: real
88	IGVCSFDP	Investment: NSRF-related: domestic public: value
89	IGVCSFEC	Investment: NSRF-related: EC: value
90	IH	Investment: total housing: real
91	IHG	Investment: public housing: real
92	IHP	Investment: housing: private: real
93	IHV	Investment: total housing: value
94	IMETOT	Investment by type of good: machinery & equipment: real
95	IMS	Investment: market services sector: real
96	IMSV	Investment: market services sector: value
97	INH	Investment: non-housing: real
98	IOTH	Investment: private non-housing: real
99	IOTHBC	Investment: private non-housing: B&C goods: real
100	IOTHME	Investment: private non-housing: M&E goods: real
101	IT	Investment: manufacturing: real
102	ITV	Investment: manufacturing: value
103	IV	Investment: total: value
104	KA	Capital stock: agriculture
105	KBC	Capital stock: building /construction
106	KGINF	Capital stock: infrastructure
107	KGINF0	Capital stock: infrastructure (without-NSRF)

108	KGINFR	Ratio of with-NSRF to without-NSRF stock of infrastructure
109	KMS	Capital stock: market services
110	KMS0	Capital stock: market services (without-NSRF)
111	KMSR	Ratio of with-NSRF to without-NSRF KMS
112	KSFTRAIN	Stock of ESF trainee years
113	KT	Capital stock: manufacturing
114	KT0	Capital stock: manufacturing (without-NSRF)
115	KTR	Ratio of with-NSRF to without-NSRF KT
116	KTRAIN	Total stock of trainee-years
117	KTRAIN0	Total stock of trainee-years(without-NSRF)
118	KTRNR	Ratio of with-NSRF to without-NSRF stock of trainee-years
119	L	Numbers employed: total (thousands)
120	LA	Numbers employed: agriculture (thousands)
121	LAEMP	Numbers employed: agriculture employees(thousands)
122	LASEMP	Numbers employed: agriculture self-employed (thousands)
123	LBC	Numbers employed: building/construction (thousands)
124	LBCEMP	Numbers employed: employees building/construction (thousands)
125	LBCSEMP	Numbers employed: self-employed building/construction (thousands)
126	LF	Total labour force (thousands)
127	LFPR	Labour force participation rate (percentage)
128	LINS	Number of ESF trainers (thousands)
129	LMS	Numbers employed: total (thousands)
130	LMSEMP	Numbers employed: total (thousands)
131	LMSSEMP	Numbers employed: total (thousands)
132	LNA	Numbers employed: total (thousands)
133	LPRBC	Labour productivity: building/construction
134	LPRMS	Labour productivity: market services
135	LPROD	Labour productivity: total economy
136	LPRT	Labour productivity: manufacturing
137	LSHRA	Wage share of added value: agriculture (percentage)
138	LSHRBC	Wage share of added value: building/construction (percentage)
139	LSHRMS	Wage share of added value: market services (percentage)
140	LSHRT	Wage share of added value: manufacturing (percentage)
141	LT	Numbers employed: total (thousands)
142	LTEMP	Numbers employed: total (thousands)
143	LTSEMP	Numbers employed: total (thousands)
144	NDPFCV	Net domestic product at factor cost: value

145	NJUV	Pre-working age population (thousands)
146	NNPFCV	Net national product at factor cost: value
147	NTS	Net trade balance: real
148	NTSV	Net trade balance: value
149	NTSVR	Net trade balance as percentage of GDP
150	OA	Value added: agriculture (real)
151	OAV	Value added: agriculture (value)
152	OBC	Value added: building/construction (real)
153	OBCV	Value added: building/construction (value)
154	OG	Value added: public sector (real)
155	OGNWV	Value added: public sector/ non wage-related (value)
156	OGV	Value added: public sector (value)
157	OMS	Value added: market services (real)
158	OMSV	Value added: market services (value)
159	OT	Value added: manufacturing (real)
160	OTV	Value added: manufacturing (value)
161	OW	World output (index)
162	PBG	Wholesale price index (CZK): Belgium
163	PCOMPT	Index of competitiveness: manufacturing
164	PCONS	Price deflator: private consumption
165	PCONSDOT	Rate of change of PCONS (percent)
166	PDS	Price deflator: stock changes
167	PFR	Wholesale price index (CZK): France
168	PG	Price deflator: public consumption
169	PGDPE	Price deflator: GDP on expenditure basis
170	PGDPFC	Price deflator: GDP at factor cost
171	PGDPM	Price deflator: GDP at market prices
172	PGE	Wholesale price index (CZK): Germany
173	PGNP	Price deflator: GNP
174	PI	Price deflator: total investment
175	PIA	Price deflator: agricultural investment
176	PIBC	Price deflator: building/construction sector investment
177	PIG	Price deflator: public sector investment
178	PIH	Price deflator: housing investment
179	PIMS	Price deflator: market services investment
180	PIT	Price deflator: manufacturing investment
181	PITA	Wholesale price index (CZK): Italy

182	PKBC	Cost of capital: building/construction
183	PKMS	Cost of capital: market services
184	PKT	Cost of capital: manufacturing
185	PM	Price deflator: private consumption
186	PNL	Wholesale price index (CZK): Netherlands
187	POBC	Price deflator: private consumption
188	POG	Price deflator: private consumption
189	POMS	Price deflator: private consumption
190	POT	Price deflator: private consumption
191	PSD	Wholesale price index (CZK): Sweden
192	PSP	Wholesale price index (CZK): Spain
193	PUK	Wholesale price index (CZK): UK
194	PUS	Wholesale price index (CZK): US
195	PWORLD	Wholesale price index (CZK): World (trade-weighted)
196	PYAFS	Price deflator: private consumption
197	PYFN	Price deflator: private consumption
198	RATWT	Real after tax wage rate in manufacturing
199	RDEBT	Ratio of national debt to GDP (percentage)
200	REPR	Replacement ratio (ratio of unemployment payment to manufacturing wage rate)
201	RFPBC	Ratio of wage to cost of capital (building/construction)
202	RFPMS	Ratio of wage to cost of capital (market services)
203	RFPT	Ratio of wage to cost of capital (manufacturing)
204	RGSUB	Implicit total rate of subsidies
205	RGTRU	Implicit total rate of unemployment income support
206	RULCT	Real unit labour cost: manufacturing
207	SAV	Household savings: real
208	SAVRAT	Household savings ratio (percentage)
209	SFTRAIN	Number of ESF trainees per year
210	SFWAG	Wage bill of ESF trainees
211	ST	Inventory stock (real)
212	TINC	Net indirect tax rate (for PCONS equation)
213	TRIA	NESF transfers to agriculture
214	TRIAEOT	NESF transfers to agriculture: real
215	TRIDP	NESF transfers to agriculture: domestic public
216	TRIEC	NESF transfers to agriculture: EC
217	TRIMS	NESF transfers to market services
218	TRIMSDP	NESF transfers to market services: domestic public

219	TRIMSEC	NESF transfers to market services: EC
220	TRIMSEOT	NESF transfers to market services: real
221	TRIT	NESF transfers to manufacturing
222	TRITDP	NESF transfers to manufacturing: domestic public
223	TRITEC	NESF transfers to manufacturing: EC
224	TRITEOT	NESF transfers to manufacturing: real
225	U	Numbers unemployed: ILO/LFS definition
226	ULCBC	Unit labour cost: building/construction
227	ULCMS	Unit labour cost: market services
228	ULCT	Unit labour cost: manufacturing
229	UR	Unemployment rate: ILO/LFS definition
230	URBAR	Two-year MA of UR
231	URP	Adjusted UR (for LFPR of ESF trainees)
232	WA	Average annual earnings in agriculture (thousands)
233	WBC	Average annual earnings in building/construction (thousands)
234	WBCDOT	Rate of change of WBC (percent)
235	WEDGE	Tax wedge (for use in WT equation)
236	WG	Average annual earnings in public sector (thousands)
237	WMS	Average annual earnings in market services (thousands)
238	WMSDOT	Rate of change of WMS (percent)
239	WNA	Average annual earnings in non-agriculture (thousands)
240	WNADOT	Rate of change of WNA (percent)
241	WT	Average annual earnings in manufacturing (thousands)
242	WTDOT	Rate of change of WT (percent)
243	WTRAIN	Average annual payments made to ESF trainees (thousands)
244	YAFS	Adjustment for financial services
245	YC	Total corporate profits (or operating surplus)
246	YCA	Operating surplus: agriculture
247	YCBC	Operating surplus: building/construction
248	YCMS	Operating surplus: market services
249	YCT	Operating surplus: manufacturing
250	YCTREP	Profit repatriation in manufacturing (due to foreign-owned firms)
251	YCU	Retained (or undistributed) profits
252	YP	Private income
253	YPER	Personal income
254	YPERD	Personal disposable income
255	YRAFS	Adjustment for financial services: real

---

256	YRFN	BOP: Net factor income: real
257	YRPERD	Personal disposable income: real
258	YRPERDPC	Personal disposable income per head: real
259	YW	Wage bill: total economy
260	YWA	Wage bill: agriculture
261	YWBC	Wage bill: building/construction
262	YWG	Wage bill: government sector
263	YWMS	Wage bill: market services
264	YWNA	Wage bill: non-agricultural
265	YWT	Wage bill: manufacturing

---

## THE HCZ5 MODEL: CALIBRATION AND WINSOLVE EQUATIONS

### E.1: WINSOLVE MODEL LISTING (ANNOTATED)

```
@ -----
@ -----
@
@
@
@           HERMIN (HCZ5)
@
@   A FIVE-SECTOR MODEL OF THE ECONOMY OF THE CZECH REPUBLIC
@
@           Last modified: October 18, 2006
@
@ -----
@
@           Definition of sectoral disaggregation of production
@
@ (T) : Manufacturing (including mining)
@ (BC) : Building and construction
@ (MS) : Market services (includes utilities, but excludes B&C)
@ (A) : Agriculture (includes forestry & fishing)
@ (G) : Non-market Services (public administration, health and education)
@
@ -----
@
@ -----
@ -- The following parameters are imposed, not estimated --
@ -- and are used for the NSRF spillover mechanisms      --
@ -----
@
@ "ETA" denotes a spillover elasticity, with the following qualifiers
@
@   TQI : Manufacturing,output spillover due to infrastructure
@   TQH : Manufacturing,output spillover due to human capital
@   TQR : Manufacturing,output spillover due to R&D
@
@ *P ETATQI = 0.20 ;
@ *P ETATQH = 0.20 ;
@ *P ETATQR = 0.05 ;
@
@   TPI : Manufacturing,labour productivity spillover due to infrastructure
@   TPH : Manufacturing,labour productivity spillover due to human capital
@   TPR : Manufacturing,labour productivity spillover due to R&D
@
@ *P ETATPI = 0.10 ;
@ *P ETATPH = 0.10 ;
@ *P ETATPR = 0.05 ;
```

```

@ MSPI : Market Services,labour productivity spillover due to infrastructure
@ MSPH : Market Services,labour productivity spillover due to human capital
@ MSPR : Market services,labour productivity spillover due to R&D

*P ETAMSPI = 0.05 ;
*P ETAMSPH = 0.05 ;
*P ETAMSPR = 0.025 ;

@ OVERHD is the training overhead (default set at 30% of wage expenditure)

*P OVERHD = 0.30 ;

@ TMUP is the fraction of manufacturing wage paid to ESF trainees (30%)

*P TMUP = 0.30 ;

@ TRATIO is the trainee/instructor ratio (default set at 1:15)

*P TRATIO = 15 ;

@ -----

@ Allocation of Structural and Cohesion Fund investment expenditure.

@ Starting with the annual total allocation of EC aid (GECSFEC_RE) in millions
@ of euro (measured at base year prices), there is a sequence of six steps:

@ Step 1:
@ -----

@ Take EC total expenditure contribution for 2007-2013 in current euro
@ as a datum (GECSFEC_E).

@ Step 2:
@ -----

@ Convert GECSFEC_E to local currency (GECSFEC) using the euro exchange rate
@ (CZKEUR, units of local currency per euro). Set parameter CZKEUR at a
@ standard rate, and freeze thereafter.

*P CZKEUR = 28.34488;

GECSFEC = GECSFEC_E * CZKEUR ;

@ Step 3:
@ -----

@ Derive the implied domestic (DP) co-finance contribution (GECSFDP), using
@ an assumed domestic co-finance ratio (RDCOFIN percent), where
@
@            $RDCOFIN=100*GECSFDP/(GECSFEC+GECSFDP);$ 

GECSFDP = (RDCOFIN/(100-RDCOFIN)) * GECSFEC;

@ Step 4:
@ -----

@ Define total (EC+DP) expenditure in local currency (GECSF). We ignore the
@ private co-finance, except for direct aid to productive sector (APS), as
@ explained below.

GECSF = GECSFEC + GECSFDP ;

```



```

@ Step 5:
@ -----

@ Disaggregate into the three main SF economic categories, where XX=EC (Community)
@ and DP (Domestic Public) contribution.

@ Physical infrastructure ----- (IGVCSFXX)
@ Human Resources ----- (GTRSFXX)
@ Direct Aid to the Productive Sector --- (TRIXX),

@ The percentage share going to Physical Infrastructure (PI) is RIGVCSF;
@ the share going to Human Resources (HR) is RGTRSF. The residual goes to
@ Direct Aid to the Productive Sector (APS).

IGVCSFEC = (RIGVCSF/100) * GECSFEC ;
IGVCSFDP = (RIGVCSF/100) * GECSFDP ;

GTRSFEC = (RGTRSF/100) * GECSFEC ;
GTRSFDP = (RGTRSF/100) * GECSFDP ;

TRIEC = GECSFEC - (IGVCSFEC+GTRSFEC) ;
TRIDP = GECSFDP - (IGVCSFDP+GTRSFDP) ;

@ Step 6:
@ -----

@ The private co-finance ratio (relative to GECSFEC) is RPVTRI. We use
@ this ratio to calculate private APS co-finance (TRIPR)

TRIPR = (RPVTRI/100) * GECSFEC ;

@ Step 7:
@ -----

@ Disaggregate Direct Aid to the Productive Sector (APS) into its two
@ sectoral allocations to Manufacturing (T) and Market Services (MS). We
@ assume a fixed proportion across all three types of finance (EC, DP and PR).
@ We exclude transfers to agriculture.

@ APS to Manufacturing (Percentage share = RTRIT):

TRITEC = (RTRIT/100) * TRIEC ;
TRITDP = (RTRIT/100) * TRIDP ;
TRITPR = (RTRIT/100) * TRIPR ;

@ APS to Market Services (defined as the residual):

TRIMSEC = TRIEC - TRITEC ;
TRIMSDP = TRIDP - TRITDP ;
TRIMSPR = TRIPR - TRITPR ;

@ Step 8:
@ -----

@ Disaggregate total APS into two main economic categories; R&D and other direct
@ aid. The percentage share of TRIEC, TRIDP and TRIPR going to R&D is RRDTCSF.
@ Use RRDTCSF to calculate total expenditure from APS going to fund R&D (TRIRD).
@ The accumulation of the constant price version of TRIRD (i.e., RTRIRD) is used
@ later to derive a measure of a "stock" of R&D (KRTRIRD)

TRIRD = (RRDTCSF/100) * (TRIEC+TRIDP+TRIPR);

```

```

@ -----
@ -----
@ ----- [I] Production: the supply side of HERMIN -----
@ -----
@ -----

@ -----
@ ----- MANUFACTURING SECTOR (T) -----
@ -----

@ OW is a trade-weighted measure of world activity in the model.

OW = exp( XWGE*log(GEIP) + XWUK*log(UKIP) + XWUS*log(USIP)
          + XWFR*log(FRIP) + XWIT*log(ITIP) + XWRU*log(RUIP)
          + XWNL*log(NLIP) + XWBG*log(BGIP) + XWSD*log(SDIP)
          + XWDK*log(DKIP) + XWHU*log(HUIP) + XWOE*log(OEIP)
          + XWSP*log(SPIP) + XWNW*log(NWIP) + XWFN*log(FNIP)
          + XWSW*log(SWIP) + XWPT*log(PTIP) );

@ Weighted domestic demand (FDOT) reflects the manufacturing output content of
@ a unit change in any of the four components of domestic demand. The
@ components used include the following:

@ CONS      : Private consumption
@ RGENW     : Non-wage public consumption
@ IH+IBCTOT : Housing and other construction investment
@ IMETOT    : Investment in machinery and equipment

@ Exports are not included in FDOT (i.e., it is not weighted "final" demand).
@ World output (OW) is directly incorporated into the output (OT) equation
@ (see below). The weights (AIOT*) are derived from input/output tables.

*P AIOTC = 0.116951; { 0.1581 (old) }
*P AIOTG = 0.0201;  { 0.0151 (old) }
*P AIOTBC = 0.143908; { 0.1411 (old) }
*P AIOTME = 0.143908; { 0.1864 (old) }

FDOT=AIOTC*CONS + AIOTG*RGENW + AIOTBC*(IH+IBCTOT)+AIOTME*IMETOT ;

@ GDP produced in the manufacturing sector (OT) is determined by a hybrid
@ supply-demand equation.

@ The influence of external factors incorporates the role of foreign direct
@ investment and portfolio investment (see Bradley and Fitz Gerald, EER, 1988).
@ The domestic demand factors represent the conventional Keynesian mechanism.

@ The driving variables are as follows:

@ OW      : World demand (proxied by world output)
@ ULCT/POT : The real unit cost of labour (equal to LSHRT)
@ FDOT    : Weighted domestic demand
@ POT/PWORLD : Relative domestic-to-world prices
@ TOT     : A time trend, to capture other shifts in the equation

@ Infrastructure, human capital and R&D spillovers are included as options in
@ the modification of OW, the effective measure of world output.
@ Note that in the baseline NSRF simulation the ratios KGINFR, KTRNR and
@ KRTRIRDR are set to unity.

@ KGINFR = increase in stock of physical infrastructure relative to baseline

```

```

@ KTRNR = increase in stock of trained labour relative to baseline
@ KRTRIRDR = increase in stock of R&D relative to baseline

*P AOT1 = 6.61744;
*P AOT2 = 0.5;
*P AOT3 = 0.5;
*P AOT4 = -0.3;
*P AOT5 = -0.3;
*P AOT6 = 0.019419;

*A
OT= exp( AOT1 + (DETATQI*ETATQI)*log(KGINFR)
        + (DETATQH*ETATQH)*log(KTRNR)
        + (DETATQR*ETATQR)*log(KRTRIRDR)
        +AOT2*log(OW)
        +AOT3*log(FDOT)
        +AOT4*log(ULCT/POT)
        +AOT5*log(PCOMPT)
        +AOT6*TOT);

@ Investment demand (IT) and labour demand (LT) are derived by cost
@ minimization, using a semi putty-clay CES production function
@ with constant returns to scale. ERFPT is the expected relative factor
@ price ratio and T represents time.

@ Bradley & Fanning, 1984 (ESRI Paper 115) gives derivations of the factor
@ demand equations (pp.309-312). Technical progress is assumed to be
@ Hicks-neutral.

@ (IT) Investment demand is the first part of the joint factor demand system.

@ Infrastructure and R&D have a total factor productivity externality effect in the
@ production function. Human capital is embodied in labour and the returns to
@ increases in human capital are internalised.

*P AT = 30.72720 ;
*P SIGT = 0.50000 ;
*P LAMT = 0.047268 ;
*P DELT = 0.15599 ;

ATX=AT * (KGINFR)^(DETATPI*ETATPI)
      * (KRTRIRDR)^(DETATPR*ETATPR);

*A
IT=OT*exp(-log(ATX) - LAMT*TT
          + SIGT/(1-SIGT)*log(1-DELT)
          + SIGT/(1-SIGT) * log (
            (DELT/(1-DELT))^(SIGT)*ERFPT^(1-SIGT) + 1.0))
      + TRITEOT;

@ The next two equations permit one to make an exogenous demand boost (TRITEOT) to
@ T-sector investment. Three types of aid are included:

@ The EC financial aid (TRITEC)
@ National public counterpart (TRITDP)
@ Domestic private sector (TRITPR)

TRIT=TRITEC+TRITDP ;

TRITEOT=(TRIT+TRITPR)/PIT ;

@ The manufacturing capital stock (KT) is accumulated using the perpetual

```

```

@ inventory formula, assuming a DEPTRAT per cent rate of depreciation and using
@ the investment series (IT) derived from the factor demand system.

KT=IT+(1-DEPTRAT)*KT(-1);

@ Note two ways to determine KT0. The equation included in the model permits
@ the definition of a baseline (no-CSF) KT0 equal to the actual KT. This can be
@ exogenised in with-CSF simulations.

KT0=KT0;
KT0=KT;

@ KTR is the ratio of the post-NSRF to the pre-NSRF capital stock
@ in the T sector. It is only different from unity in with-NSRF simulations.

KTR=(KT/KT0) ;

@ (LT) Labour demand is the second part of the joint factor demand system.

@ The effective input of labour is LT * KTRNR^(DETATPH*ETATPH), where
@ KTRNR is a training stock ratio dependent on NSRF training expenditures
@ This is equivalent to augmenting the labour-embodied technical progress
@ term, LAMLT

*A
LT=OT*exp(-(DETATPH*ETATPH)*log(KTRNR)-log(ATX)-LAMT*TT
           + SIGT/(1-SIGT)*log(DELT)
           + SIGT/(1-SIGT) * log(
             (DELT/(1-DELT))^(-SIGT)*ERFPT^(SIGT-1) + 1.0 ));

@ Split total employment between self-employed (LTSEMP) and employees (LTEMP)

LTSEMP=SETRAT*LT;

LTEMP=LT-LTSEMP;

@ The deflator of manufacturing added-value in the local currency (POT)
@ is determined by the "world" price in the local currency (PWORLD) and
@ by a mark-up on unit labour costs (ULCT). Price homogeneity is imposed.

*P APOT1 = 0.326750 ;
*P APOT2 = 0.7 ;

*M
log(POT) = APOT1+APOT2*log(PWORLD)+(1-APOT2)*log(ULCT) ;

@ The local currency world price (PWORLD) and import price (PM) are related to
@ a selection of prices in trading partners (in local currency) and the corresponding
@ bilateral exchange rates. There are two categories: euro-zone countries and non
@ euro-zone countries

@ Euro-zone wholesale prices (Germany, Italy, France, Spain, the Netherlands, Bel-
@ gium)

PGE=GEP*(CZKDM/18.51783399);

PITA=ITP*(CZKILI/0.016303656);

PFR=FRP*(CZKFRF/5.316743083);

PSP=SPP*(CZKESP/0.212844387);

PNL=NLP*(CZKNLG/16.53054545);

```

```

PBG=BGP*(CZKGBF/0.900011581);

@ Non-euro-zone prices (UK, Sweden, USA)

PUK=UKP*(CZKGBP/41.89231225);

PSD=SDP*(CZKSEK/3.723450593);

PUS=USP*(CZKUSD/26.54516206);

@ Export-weighted world wholesale price, in local currency

PWORLD = exp( XW1*log(PGE) + XW2*log(PUS) + XW3*log(PITA) + XW4*log(PFR) +
              XW5*log(PUK) + XW6*log(PNL) + XW7*log(PBG) + XW8*log(PSD) +
              XW9*log(PSP) );

@ Czech import deflator is linked to import-weighted world prices, in local currency.
@ This is only an approximation, so there are residuals.

*M
log(PM) = MW1*log(PGE) + MW2*log(PUS) + MW3*log(PITA) + MW4*log(PFR) +
         MW5*log(PUK) + MW6*log(PNL) + MW7*log(PBG) + MW8*log(PSD) +
         MW9*log(PSP) ;

@ Manufacturing productivity (LPRT) is defined as GDP produced in the sector (OT)
@ per unit of labour (LT).

LPRT=OT/LT;

@ Average annual earnings in manufacturing (WT) are determined in a
@ bargaining model by output prices (POT), a tax wedge (WEDGE),
@ a two-year average of the unemployment rate (URBAR) and productivity (LPRT).
@ The basic version of the equation imposes full price indexation.

@ For theoretical background to wage bargaining, see: (Layard, Nickell and Jackman,
@ Unemployment, 1991, pp. 173-214).

*P AWT1 = 0.741379 ;
*P AWT2 = 0.8 ;
*P AWT3 = -0.02 ;

*M
log(WT) = log(POT) + (AWT1+AWT2*log(LPRT)+ AWT3*URBAR) ;

@ The rate of wage inflation (WTDOT) is defined

WTDOT=100*(WT/WT(-1)-1);

@ The cost of capital in manufacturing (PKT) is determined by the investment
@ price (PIT) and an exogenous average "real" rate of interest (RRSA). This
@ simple formulation is used as a starting point (see Brechling, Investment
@ and Employment Decisions, 1975, pp. 7-17). We assume that the real rate of
@ return on investment (RRSA) is fixed at 8%

PKT=PIT*(DEPTRAT + RRSA/100);

@ RFPT is the relative factor price (labour (WT) relative to capital (PKT)).

RFPT=WT/PKT;

@ Expectations for the relative factor price are assumed to be

```

@ backward-looking.

ERFPT = (RFPT+0.75\*RFPT(-1))/(1+0.75);

@ The unit labour cost in manufacturing (ULCT) is defined as the manufacturing  
@ wage bill (YWT) per unit of real added-value in manufacturing (OT).

ULCT=YWT/OT;

@ Real unit labour costs (RULCT) are defined by deflating nominal unit labour  
@ costs (ULCT) by the output deflator (POT). It is equivalent to labour's  
@ share of added-value (LSHRT)

RULCT = ULCT/POT;

@ International price competitiveness (PCOMPT) is defined as the ratio of  
@ manufacturing prices (POT) to world prices (PWORLD), both denominated in  
@ the local currency.

PCOMPT = POT/PWORLD;

@ The value of T-sector GDP (OTV) is calculated from the price (POT) and the  
@ volume (OT).

OTV=POT\*OT;

@ The manufacturing wage bill (YWT) is the product of numbers employed (LT)  
@ and the wage rate (WT).

YWT=LTEMP\*WT;

@ Labour share of added-value in manufacturing (LSHRT) is the wage bill (YWT)  
@ divided by the value of output (OTV).

LSHRT= 100\*(YWT/OTV);

@ Profits in the T-sector (YCT) are derived residually by subtracting the  
@ wage bill (YWT) from added-value in the T-sector (OTV). Note that profits  
@ are assumed to be retained in the domestic economy and not repatriated.

YCT=OTV-YWT;

@ Profits repatriated by foreign firms (YCTREP) are asumed to be a constant  
@ fraction (KYCTREP) of total profits in manufacturing (YCT)

YCTREP = KYCTREP \* YCT ;

```
@
@ -----
@ ----- MARKET SERVICES SECTOR (MS) -----
@ -----
```

@ The weighted domestic demand measure (FDOMS) reflects the MS-sector output  
@ content of a unit change in any of the components of domestic demand.  
@ The components used are the same as for manufacturing (T) above, i.e.,  
@ private consumption (CONS), non-wage public consumption (RGENW), housing  
@ and other construction investment (IH+IBC), and investment in machinery and  
@ equipment (IME). The weights (AION\*) are derived from input/output tables.

```
*P AIOMSC = 0.471463;          { 0.3886 (old) }
*P AIOMSG = 0.116184;          { 0.07 (old) }
```

```

*P AIOMSBC = 0.420179;          { 0.5061 (old) }
*P AIOMSME = 0.420179;          { 0.4316 (old) }

FDOMS=AIOMSC*CONS + AIOMSG*RGENW + AIOMSBC*(IH+IBCTOT)+AIOMSME*IMETOT;

@ GDP arising in the MS-sector (OMS) is determined by weighted domestic demand
@ (FDOMS), world demand (proxied by OW) and a time trend (TOMS).

*P AOMS1 = 6.44775 ;
*P AOMS2 = 0.489211 ;
*P AOMS3 = -0.454691 ;
*P AOMS4 = 0.012250 ;

*A
OMS = exp( AOMS1+AOMS2*log(FDOMS)+AOMS3*log(ULCMS/POMS)+AOMS4*TOMS );

@ Investment (IMS) and labour demand (LMS) are derived using cost minimization,
@ using a semi putty-clay CES production function with constant returns to scale.
@ ERFPMs is the expected relative factor price ratio and T is time.

@ Bradley & Fanning, 1984 (ESRI Paper 115) gives derivations of factor demand
@ equations (pp.309-312). Technical progress is assumed to be Hicks-neutral.

@ The CES parameters that characterize market services (MS) are derived by
@ calibration to the data.

*P AMS = 20.85560 ;
*P SIGMS = 0.50000 ;
*P LAMMS = 0.022879 ;
*P DELMS = 0.065470 ;

@ There is a total factor productivity externality, due to infrastructure
@ and R&D, as in the T-sector (see above).

AMSX = AMS * (KGINFR)^(DETAMSPI*ETAMSPI)
        * (KRTRIRDR)^(DETAMSPR*ETAMSPR) ;

@ Investment demand (IMS) is the first part of the joint factor demand system.

*A
IMS=OMS*exp(-log(AMSX) - LAMMS*TMS
            + SIGMS/(1-SIGMS)*log(1-DELMS)
            + SIGMS/(1-SIGMS) * log(
              (DELMS/(1-DELMS))^SIGMS*ERFPMs^(1-SIGMS)+ 1.0)
            + TRIMSEOT ;

@ The next two equations permit one to make an exogenous boost (TRIMSEOT) to
@ investment by the MS-sector. Three types of aid are included: EU (TRIMSEC),
@ national public counterpart (TRIMSDP) and private sector (TRIMSPR)

TRIMS=TRIMSEC+TRIMSDP ;

TRIMSEOT=(TRIMS+TRIMSPR)/PIMS ;

@ The capital stock (KMS) is accumulated from investment flows (IMS) using the
@ perpetual inventory formula, with a depreciation rate of DEPMSRAT per cent.

KMS=IMS+(1-DEPMSRAT)*KMS(-1);

@ Note two variants of equation for KMS0. The second permits the definition of
@ a baseline KMS0 equal to the actual KMS. The first permits one to exogenise KMS0
@ in NSRF-type simulations.

```

```

KMS0=KMS0;
KMS0=KMS;

@ KMSR defines the increase in the MS-sector capital stock (KMS) relative to an
@ ex-ante baseline (KMS0)

KMSR=(KMS/KMS0) ;

@ Labour demand (LMS) is the second part of the joint factor demand system.

@ The effective input of labour is LMS * KTRNR^(DETAMSPH*ETAMSPH). This is
@ equivalent to changing the labour-embodied technical progress term, LAMLMS

*A
LMS=OMS*exp(-(DETAMSPH*ETAMSPH)*log(KTRNR)-log(AMSX)-LAMMS*TMS
             + SIGMS/(1-SIGMS)*log(DELMS)
             + SIGMS/(1-SIGMS) * log(
               (DELMS/(1-DELMS))^( -SIGMS)*ERFPMS^(SIGMS-1) + 1.0 )) ;

@ Split total employment between self-employed (LMSSEMP) and employees (LMSEMP)

LMSSEMP=SEMSRAT*LMS;

LMSEMP=LMS-LMSSEMP;

@ The MS-sector output price deflator (POMS) is determined as a mark-up on
@ unit labour costs (ULCMS). Note the one-year lag and the imposition of price
@ homogeneity.

*P APOMS1 = 0.974531 ;
*P APOMS2 = 0.732898 ;

*M
log(POMS) = APOMS1+APOMS2*log(ULCMS)+(1-APOMS2)*LOG(ULCMS(-1)) ;

@ Labour productivity (LRPMS) is defined as the ratio of output (OMS) to
@ employment (LMS).

LRPMS=OMS/LMS;

@ The Scandinavian model assumption of sectorally homogeneous labour markets
@ is invoked to equate MS-sector wage inflation (WMS/WMS(-1)) to wage inflation in
@ manufacturing (WT/WT(-1)). This is imposed as an identity, but is a
@ crucial behavioural assumption. Its validity must be checked to ensure that
@ it is consistent with the actual data for each country.

@ For background research on the Scandinavian model, see Lindbeck (ed.),
@ Inflation and Employment in Open Economies, 1979.

*A
WMS = WMS(-1)* WT/WT(-1) ;

@ The annual inflation rate (WMSDOT) is defined.

WMSDOT=100*(WMS/WMS(-1)-1);

@ The cost of capital (PKMS) is determined by the investment price (PIMS) and
@ an average "real" interest rate (RRSA) (see remarks above on PKT).

PKMS=PIMS*(DEPMSRAT + RRSA/100);

@ RFPMS is the relative factor price ratio (labour (WMS) to capital (PKMS))

```



RFPMS=WMS/PKMS;

@ Expectations of relative factor prices (ERFPMS) are formed by a simple one-  
@ period backward-looking moving average.

ERFPMS = (RFPMS+0.75\*RFPMS(-1))/(1+0.75);

@ Unit labour cost (ULCMS) is derived from the wage bill (YWMS) divided  
@ by real output (OMS)

ULCMS=YWMS/OMS;

@ The value of MS-sector GDP (OMSV) is determined as the product of the  
@ price (POMS) and real output (OMS).

OMSV=POMS\*OMS;

@ The N-sector wage bill (YWMS) is the product of employment (LMS) and the  
@ wage rate (WMS).

YWMS=LMSEMP\*WMS;

@ Labour's share of added value in the MS-sector (LSHRMS) is calculated  
@ from the wage bill (YWMS) and the value of output (OMSV).

LSHRMS=100\*YWMS/OMSV;

@ Profits in the MS-sector (YCMS) are derived by subtracting the wage bill  
@ (YWMS) from the value of MS-sector GDP (OMSV)

YCMS=OMSV-YWMS;

@ -----  
@ ----- The building & construction sector (BC) -----  
@ -----

@ GDP in the BC-sector (OBC) is determined by total B&C-type investment  
@ (IBCTOT) and real unit labour costs (ULCBC/PCONS).

\*P AOBC1 = -0.684148 ;  
\*P AOBC2 = 1.0 ;  
\*P AOBC3 = -1.06716 ;  
\*P AOBC4 = -0.109448 ;

\*A

OBC = exp( AOBC1+AOBC2\*log(IBCTOT)+AOBC3\*log(ULCBC/POBC)+AOBC4\*TOBC );

@ Investment (IBC) and labour demand (LBC) are derived using cost  
@ minimization, using a semi putty-clay CES production function  
@ with constant returns to scale, as in the T-sector (see above).  
@ ERFPBC is the expected relative factor price ratio and T is time.

@ CES parameters characterizing B&C (BC) are derived by calibration to the data.

\*P ABC = 125.18341 ;  
\*P SIGBC = 0.50000 ;  
\*P LAMBC = -0.030636 ;  
\*P DELBC = 0.45482 ;

@ Investment demand (IBC) is the first part of the joint factor demand system.

\*A

$$IBC = OBC \cdot \exp(-\log(ABC) - LAMBC \cdot TBC + \frac{SIGBC}{1-SIGBC} \cdot \log(1-DELBC) + \frac{SIGBC}{1-SIGBC} \cdot \log(\frac{DELBC}{1-DELBC})^{SIGBC} \cdot ERFPC^{(1-SIGBC)+1.0}) ;$$

@ The capital stock (KBC) is accumulated from investment flows (IBC) using the @ perpetual inventory formula, with a depreciation rate of DEPBCRAT per cent.

$$KBC = IBC + (1-DEPBCRAT) \cdot KBC(-1) ;$$

@ Labour demand (LBC) is the second part of the joint factor demand system.

\*A

$$LBC = OBC \cdot \exp(-\log(ABC) - LAMBC \cdot TBC + \frac{SIGBC}{1-SIGBC} \cdot \log(DELBC) + \frac{SIGBC}{1-SIGBC} \cdot \log(\frac{DELBC}{1-DELBC})^{(-SIGBC) \cdot ERFPC^{(SIGBC-1)+1.0}}) ;$$

@ Split LBC into employees (LBCEMP) and self-employed (LBCSEMP)

$$LBCSEMP = SEBCRAT \cdot LBC ;$$

$$LBCEMP = LBC - LBCSEMP ;$$

@ The BC-sector output price deflator (POBC) is determined as a @ mark-up on unit labour costs (ULCBC). Note the one-year lag @ and the imposition of price homogeneity.

$$*P \text{ APOBC1} = 0.805506 ;$$

$$*P \text{ APOBC2} = 0.311770 ;$$

\*M

$$\log(POBC) = APOBC1 + APOBC2 \cdot \log(ULCBC) + (1-APOBC2) \cdot \log(ULCBC(-1)) ;$$

@ Labour productivity (LRPBC) is defined as the ratio of output (OBC) to @ employment (LBC).

$$LRPBC = OBC / LBC ;$$

@ The Scandinavian model assumption of sectorally homogeneous labour markets @ is invoked to equate BC-sector wage inflation (WNC/WBC(-1)) to wage inflation @ in manufacturing (WT/WT(-1)). This is imposed as an identity, but is a @ crucial behavioural assumption. Its validity must be checked to ensure that @ it is consistent with the actual data for each country.

@

@ For background research on the Scandinavian model, see Lindbeck (ed.), @ Inflation and Employment in Open Economies, 1979.

\*A

$$WBC = WBC(-1) \cdot (WT/WT(-1)) ;$$

@ The annual inflation rate (WBCDOT) is defined.

$$WBCDOT = 100 \cdot (WBC/WBC(-1) - 1) ;$$

@ The cost of capital (PKBC) is determined by the investment price (PIBC) and @ an average "real" interest rate (RRSA) (see remarks above on PKT).

$$PKBC = PIBC \cdot (DEPBCRAT + RRSA/100) ;$$

@ RFPBC is the relative factor price (labour (WBC) to capital (PKBC))  
 @ to the cost of capital (PKBC).

$$\text{RFPBC} = \text{WBC} / \text{PKBC};$$

@ Expectations of relative factor prices (ERFPBC) are formed by a simple  
 @ one-period backward-looking moving average.

$$\text{ERFPBC} = (\text{RFPBC} + 0.75 * \text{RFPBC}(-1)) / (1 + 0.75);$$

@ Unit labour cost (ULCBC) is derived from the wage bill (YWBC) divided  
 @ by real output (OBC)

$$\text{ULCBC} = \text{YWBC} / \text{OBC};$$

@ The value of BC-sector GDP (OBCV) is determined as the product of the  
 @ price (POBC) and real output (OBC).

$$\text{OBCV} = \text{POBC} * \text{OBC};$$

@ The BC-sector wage bill (YWBC) is the product of numbers of employees  
 @ (LBCEMP) and the wage rate (WBC).

$$\text{YWBC} = \text{LBCEMP} * \text{WBC};$$

@ Labour's share of added value in the BC-sector (LSHRBC) is calculated  
 @ from the wage bill (YWBC) and the value of output (OBCV).

$$\text{LSHRBC} = 100 * (\text{YWBC} / \text{OBCV});$$

@ Profits in the BC-sector (YCBC) are derived by subtracting the wage bill  
 @ (YWBC) from the value of BC-sector GDP (OBCV)

$$\text{YCBC} = \text{OBCV} - \text{YWBC};$$

@

@ -----  
 @ ----- AGRICULTURE SECTOR (A) -----  
 @ -----

@ No attempt is made in this version of HERMIN to construct a behavioural  
 @ model of the agriculture sector. However, we separate out the key  
 @ components of agriculture from the rest of the private non-agriculture  
 @ sector (i.e., manufacturing and market services). A series of simple  
 @ time trends is used to endogenise these components.

@ Agricultural GDP (OA) is determined from a time-trended labour  
 @ productivity relationship (TOA).

$$\begin{aligned} *P \text{AOA1} &= 4.86740; \\ *P \text{AOA2} &= 0.083699; \end{aligned}$$

\*A  

$$\text{OA} = \text{LA} * \exp(\text{AOA1} + \text{AOA2} * \text{TOA});$$

@ Numbers engaged in agriculture (employees and self employed) (LA)  
 @ are modelled as an exponential time trend (TLA).

$$*P \text{ALA1} = 6.05676;$$

```

*P ALA2 = -0.060088 ;

*A
LA = exp( ALA1+ALA2*TLA );

@ Split LA into employees (LAEMP) and self-employed (LASEMP)

LASEMP = SEARAT*LA;

LAEMP = LA - LASEMP;

@ The capital intensity of agricultural output (KA/OA) is modelled as
@ an exponential time trend (TKA).

*P AKA1 = 1.66061 ;
*P AKA2 = -0.014204 ;

*A
KA = OA * exp( AKA1+AKA2*TKA );

@ The next two equations permit one to make an exogenous boost
@ (TRIAEOT) to investment by the A-sector. Three types of aid
@ are included: EU (TRIAEC), national public counterpart
@ (TRIADP) and private sector (TRIAPR)

TRIA=TRIAEC+TRIADP ;

TRIAEOT=(TRIA+TRIAPR)/PIA ;

@ Agricultural investment (IA) is recovered by inverting the perpetual
@ inventory formula used to define the capital stock (KA), where DEPAA
@ is the assumed depreciation rate.

IA =KA-(1-DEPARAT)*KA(-1) + TRIAEOT ;

@ The "Scandinavian" model assumption of homogeneous labour markets is
@ invoked to equate A-sector wage inflation (WA/WA(-1)) to wage inflation in
@ manufacturing (WT/WT(-1)). This is imposed as an identity, but must be
@ checked to ensure that it is consistent with observed data. See note on
@ WN above for background research.

*A
WA = WA(-1) * (WT/WT(-1)) ;

@ Wage income in the A-sector (YWA) is the product of LA and WA.

YWA = LAEMP*WA;

@ The value of GDP arising in the A-sector (OAV) is calculated as the product
@ of the deflator (POA) and the volume (OA).

OAV=POA*OA;

@ Labour's share of added value in the A-sector (LSHRA) is calculated
@ from the wage bill (YWA) and the value of output (OAV).

LSHRA=100*(YWA/OAV);

@ Profits in the A-sector (YCA) are derived by subtracting the wage bill
@ (YWA) from the value of A-sector GDP (OAV)

YCA=OAV-YWA;

```

```

@          -----
@          -----  NON-MARKET SERVICES SECTOR (G)  -----
@          -----

```

@ The value of GDP arising in the G-sector (OGV) is measured mainly by wage  
@ inputs (YWG) but also includes a (small) non-wage element (OGNWV).

OGV = YWG + OGNWV;

@ The value of the non-wage element of G-sector output (OGNWV) is indexed to  
@ the deflator of output (POG) and (exogenous) real non-wage consumption (OGNW)

OGNWV=POG\*OGNW + OVERHD\*SFWAG ;

@ Real G-sector GDP (OG) is calculated by deflating nominal GDP (OGV)  
@ by the sectoral output price (POG).

OG = OGV/POG;

@ The "Scandinavian" model assumption of homogeneous labour markets is  
@ invoked to equate G-sector wage inflation (WG/WG(-1)) to wage inflation in  
@ manufacturing (WT/WT(-1)). This is imposed as an identity, but must be  
@ checked to ensure that it is consistent with observed data. See note on  
@ WN above for background research.

\*A  
WG = WG(-1) \* (WT/WT(-1)) ;

@ The inflation rate of the deflator of G-sector output (POG/POG(-1))  
@ is equated to G-sector wage inflation (WG/WG(-1)), since they are  
@ essentially the same entity.

\*A  
POG = POG(-1) \* (WG/WG(-1));

@ The G-sector wage bill (YWG) is the product of employment (LG) and the  
@ wage rate (WMS). ESF instructors are assumed to be in the YWG wage bill.

YWG=LG\*WG + LINS\*WMS ;

```

@          -----
@          ---  Demographics and labour supply  ---
@          -----

```

@ Determination of total population (N), working population (NWORK) and  
@ retired population (NGE60) can be modelled as an exponential growth process,  
@ corrected for international migration (NM). Here it is exogenised.

@ The youth dependent population (NJUV) is computed residually.

NJUV=N-NELD-NWORK;

@ The labour force participation rate (LFPR) is determined by the  
@ unemployment rate (URBAR) - the discouraged worker effect and a  
@ time trend (TLFPR).

\*P ALFPR1 = 78.3671 ;

\*P ALFPR2 = -0.427451 ;

\*A

LFPR = ALFPR1 + ALFPR2\*TLFPR;

@ The labour force (LF) is obtained in an identity from the participation  
@ rate (LFPR) and the population of working age (NWORK).

LF = (LFPR/100)\*NWORK - TFRACT\*SFTRAIN ;

@ Total non-agricultural employment (LNA) is the summation of numbers employed  
@ in the T, BC, MS and G sectors.

LNA = LT+LBC+LMS+(LG+LINS);

@ Total employment (L) is the summation of numbers employed in the five sectors  
@ T, BC, MS, A and G.

L = LNA + LA ;

@ Unemployment is defined according to the ILO standard. The numbers  
@ unemployed (U) are residually determined as the difference between  
@ labour supply (LF) and labour demand (L).

U=LF-L;

@ The (percentage) unemployment rate (UR) is defined as the ratio of numbers  
@ unemployed (U) to the labour force (LF).

UR=100\*(U/LF);

@ URP is a modified measure of the unemployment rate, designed to permit  
@ a distinction to be made between the actual rate of unemployment (UR)  
@ and the manner in which SF-induced changes in unemployment influence  
@ wage bargaining. If TFRACT is zero, all the new trainees are assumed to  
@ have been long-term unemployed and have minimal impact on wage  
@ bargaining. In this case there is little or no movement in URP. If  
@ TFRACT is unity, all are assumed to be short-term unemployed and the  
@ increase in SF trainees is fully reflected in URP.

URP=100\*(LFPR/100\*NWORK-TFRACT\*SFTRAIN-L)/(LFPR/100\*NWORK-TFRACT\*SFTRAIN);

@ URBAR defines a moving average unemployment rate for use in the wage  
@ equation (WT) in manufacturing. Its role is to "dampen" responses of  
@ wages to changes in UR.

URBAR = (URP+URP(-1))/2;

@ The real after-tax average annual earnings in manufacturing (RATWT)  
@ is defined as the nominal wage (WT) corrected for direct taxation (RGTYP),  
@ and deflated by the consumption price (PCONS).

RATWT=WT\*(1-RGTYP-RGTYSOCW)/PCONS;

@ -----  
@ -----  
@ ----- [II] Absorption and the demand side of HERMIN -----  
@ -----  
@ -----

@ --- Determination of domestic absorption

```

@ Household consumption (CONS)
@ -----

@ A simple Keynesian consumption function is specified. Consumers are
@ assumed to be backward-looking and completely liquidity constrained.

*P ACONS1 = -146917.0 ;
*P ACONS2 =      0.793712 ;

*A
CONS=ACONS1+ACONS2*YRPERD;

@ The value of household consumption (CONSV) is derived as the product of
@ the consumption deflator (PCONS) and the volume of consumption (CONS).

CONSV=PCONS*CONS;

@ Savings (SAV) are defined as nominal disposable income (YPERD) less
@ household consumption (CONSV).

SAV = YPERD - CONSV;

@ The personal savings ratio (SAVRAT) is defined as the ratio of savings
@ (SAV) to personal disposable income (YPERD).

SAVRAT = 100*SAV/YPERD;

@ Public consumption (G)
@ -----

@ The value of public consumption (GV) is determined by the wage bill (YWG)
@ plus a (small) non-wage nominal element (GENW).

GV=YWG+GENW;

@ The volume of total public consumption (G) is obtained by deflating GV by PG

G=GV/PG;

@ Basic non-wage public consumption is kept fixed in real terms.
@ The overhead element in the SF programme (OVERHD*SFWAG) is
@ counted as part of GENW (see OGNWV earlier)

GENW=PG*RGW + OVERHD*SFWAG;

@ Private housing investment (IHP) is modelled as a share (KIHP) of gross
@ domestic expenditure (GDE).

@ Investment (IV, I)
@ -----

IHP = KIHP*GDPE ;

@ The value of public housing investment (IHGV) is exogenous. The volume of
@ public investment in housing (IHG) is obtained by deflating IHGV with PIH,
@ the total housing investment deflator.

IHG=IHGV/PIH;

```

@ Total housing investment (IH) is the sum of public (IHG) and private (IHP)  
 @ housing investment.

$$IH = IHG + IHP;$$

@ The value of total housing investment (IHV) is the product of the  
 @ deflator (PIH) and the volume of housing investment (IH).

$$IHV = PIH * IH;$$

@ Real non-housing public sector investment (IG) is obtained by deflating the  
 @ (exogenous) nominal investment instrument (IGV) by the deflator (PIG).

@ Total public sector investment includes NSRF and non-NSRF elements

$$IG = (IGV + IGVCSE + LOCEC + LOCDP + LOCPR) / PIG;$$

@ The value of investment in manufacturing (ITV) is the product of the  
 @ T-sector investment deflator (PIT) and real T-sector investment (IT).

$$ITV = PIT * IT;$$

@ The value of investment in building and construction (IBCV) is the product of  
 @ the BC-sector investment deflator (PIBC) and real BC-sector investment (IBC).

$$IBCV = PIBC * IBC;$$

@ The value of investment in market services (IMSV) is the product of the  
 @ MS-sector investment deflator (PIMS) and real MS-sector investment (IMS).

$$IMSV = PIMS * IMS;$$

@ The value of investment in agriculture (IAV) is the product of the  
 @ A-sector investment deflator (PIA) and real A-sector investment (IA).

@ The value of investment in agriculture (IAV).

$$IAV = PIA * IA;$$

@ Total real investment (I) is the sum of sectoral investment in the  
 @ T, N, A and G sectors, plus housing investment (IH) and a residual category.

$$I = (IT + IBC + IMS + IA + IG) + IH + STDISI ;$$

@ Total investment excluding housing (INH) is obtained from an identity.

$$INH = I - IH;$$

@ Both public and private sector fixed non-housing investment (IGINF and IOTH),  
 @ which add to INH, are now disaggregated into building and construction (B&C)  
 @ and machinery and equipment (M&E). Such a breakdown is essential for the  
 @ appropriate modelling of weighted domestic demand measures such as FDOT  
 @ and FDON.

@ The B&C element of investment has a much greater domestic output content  
 @ than for M&E, which is largely imported. An exogenous fraction WIGME of  
 @ public investment (IGINF) is assumed to be M&E (i.e., IGINFME). Note that  
 @ IGINF is defined later in the expenditure side of the public sector accounts.

@ The M&E element of public investment (IGINFME) is assumed to be a constant  
 @ fraction (WIGME) of total public investment (IGINF).

$$IGINFME = WIGME * IGINF;$$



@ Public investment in B&C (IGINFBC) is then residually calculated.

IGINFBC = IGINF - IGINFME;

@ Private non-housing investment (IOTH) is residually calculated from total  
@ non-housing investment (INH) and public investment (IGINF).

IOTH = INH - IGINF;

@ The M&E element of private investment (IOTHME) is assumed to be a constant  
@ fraction (WIOME) of total private investment (IOTH).

IOTHME = WIOME \* IOTH;

@ Private non-housing investment in B&C (IOTHBC) is residually calculated.

IOTHBC = IOTH - IOTHME;

@ The objective of the above calculations is to end up with a two-way split of  
@ total non-housing investment (INH) into two components: B&C (IBC) and M&E  
@ (IME). These can then be used in the weighted domestic demand variables  
@ FDOT and FDON in the manufacturing and market service sector output  
@ determination.

IBCTOT = IGINFBC + IOTHBC;

IMETOT = IGINFME + IOTHME;

@ The value of total investment (IV) is the sum of sectoral investments in the  
@ T, BC, N, A and G sectors, plus housing investment (IHV).

IV=(ITV+IBCV+IMSV+IAV)+(IGV+IGVCSF+LOCEC+LOC DP+LOCPR)+IHV + STDISIV ;

@ The deflator of total investment (PI) is calculated as the ratio of  
@ the value (IV) to volume (I) of total investment.

PI=IV/I;

@ Inventory changes (DSV, DS) - set exogenous

@ -----

@ Stock changes (DS) can be modelled as a partial adjustment  
@ process to a target stock/output ratio (ST/OT).

@

@ \*P ADS1 = 0.051371 ;

@ \*P ADS2 = -0.026142 ;

@

@ \*A

@ DS=ADS1\*OT+ADS2\*ST(-1);

@ The stock of inventories (ST) is defined as the accumulation of inventory  
@ changes (DS).

ST=DS+ST(-1);

@ The value of stock changes is derived from the appropriate deflator  
@ (PDS) and real stock changes (DS).

DSV=PDS\*DS;

@ Net trade balance (NTSV, NTS)  
 @ -----

@ The net trade surplus in real terms (NTS) is residually determined from  
 @ GDP on an output basis (GDPM, to be defined later), less consumption  
 @ (CONS + G), investment (I) and stock changes (DS), and includes a  
 @ statistical discrepancy (STATDIS) from the National Accounts, where  
 @  $GDPE = GDPM + STATDIS$

$NTS = (GDPM + DIFGDPE) - (CONS + I + G + DS) - STDISE;$

@ The net trade surplus in value terms (NTSV).

$NTSV = (GDPMV + DIFGDPEV) - (CONSV + IV + GV + DSV);$

@ -----  
 @ --- National expenditure and demand identities ---  
 @ -----

@ GDP on an expenditure basis (GDPEV) is the sum of personal consumption  
 @ (CONSV), total investment (IV), public consumption (GV), stock changes  
 @ (DSV) and the net trade surplus (NTSV).

$GDPEV = (CONSV + IV + GV + DSV) + NTSV;$

@ Note two variants of equation for GDPEV0. The second permits the  
 @ definition of a baseline GDPEV0 equal to the actual GDPEV. The first  
 @ permits one to exogenise GDPEV0 in NSRF-type simulations.

$GDPEV0 = GDPEV0;$   
 $GDPEV0 = GDPEV;$

@ GDP on an expenditure basis, in real terms.

$GDPE = (CONS + I + G + DS) + NTS + STDISE ;$

@ The deflator of GDP on an expenditure basis (PGDPE).

$PGDPE = GDPEV / GDPE;$

@ -----  
 @ ----- Absorption price determination -----  
 @ -----

@ All domestic absorption prices are determined in terms of the deflators of  
 @ their two main components: GDP at factor cost (PGDPFC) and imports (PM).  
 @ The deflator of GDP at factor cost (PGDPFC) is defined later.

@ Deflator of investment in manufacturing (PIT)

\*P APIT1 = -0.011617 ;  
 \*P APIT2 = 0.335233 ;

\*A  
 $PIT = \exp( APIT1 + APIT2 * \log(PGDPFC) + (1 - APIT2) * \log(PM) );$

@ Deflator of investment in building & construction (PIBC)

\*P APIBC1 = -0.058875 ;

```

*P APIBC2 = 0.965579 ;

*A
PIBC = exp( APIBC1+APIBC2*log(PGDFFC)+(1-APIBC2)*log(PM) );

@ Deflator of investment in market services (PIMS)

*P APIMS1 = -0.00667038 ;
*P APIMS2 = 0.662822 ;

*A
PIMS = exp( APIMS1+APIMS2*log(PGDFFC)+(1-APIMS2)*log(PM) );

@ Deflator of investment in agriculture (PIA)

*P APIA1 = -0.00510274 ;
*P APIA2 = 0.395608 ;

*A
PIA = exp( APIA1+APIA2*log(PGDFFC)+(1-APIA2)*log(PM) );

@ The deflator of public investment (PIG)
@ TSP results:

*P APIG1 = 0.00414277;
*P APIG2 = 0.694542 ;

*A
PIG = exp( APIG1+APIG2*log(PGDFFC)+(1-APIG2)*log(PM) );

@ The deflator of investment in housing (PIH).

*P APIH1 = 0.056482 ;
*P APIH2 = 0.9 ;

*A
PIH = exp( APIH1+APIH2*log(PGDFFC)+(1-APIH2)*log(PM) );

@ The deflator of personal consumption (PCONS). Note that all net
@ indirect taxes (TINC) are assumed to bear on consumption prices.
@ TINC is defined later in the tax revenue part of the model.

*P APCONS1 = -0.208484 ;
*P APCONS2 = 0.916158 ;
*P APCONS3 = 1.0 ;

*A
PCONS = exp( APCONS1+APCONS2*log(PGDFFC)+(1-APCONS2)*log(PM)
            +APCONS3*RGTEPD );

PCONSDOT=100*(PCONS/PCONS(-1))-1);

@ The inflation rate of the deflator of government consumption (PG) is taken
@ to be the same as for the deflator of public sector GDP (POG).

*A
PG = PG(-1) * (POG/POG(-1)) ;

@ The deflator of non-agricultural stock changes (PDST).

*P APDS1 = -0.193763;
*P APDS2 = 0.8 ;

```

```

*A
PDS = exp( APDS1+APDS2*log(PGDPFC)+(1-APDS2)*log(PM) );

@ The deflator of the National Accounting item "adjustment for financial
@ services" (PYAFS) is linked to the ON deflator (POMS).

*A
PYAFS = PYAFS(-1) * (POMS/POMS(-1));

@ The deflator of net factor income (PYFN) is linked to the ON deflator (POMS).

*A
PYFN = PYFN(-1) * (POMS/POMS(-1));

@ -----
@ -----
@ ----- [III] Income distribution in HERMIN -----
@ -----
@ -----

@ -----
@ --- Public sector : government expenditure and revenue ---
@ -----

@ -----
@ --- Public expenditure ---
@ -----

@ ----- Public consumption -----

@ Public sector expenditure on wages (GEW) is identical to the public sector
@ wage bill (YWG).

GEW = YWG;

@ Non-wage public consumption (GENW) is obtained from real non-wage
@ consumption (RGENW), which is exogenous, reflatd using the public
@ consumption deflator (PG).

GENW = PG*RGENW;

@ ----- Subsidies -----

@ Subsidies (GSUBPD and GSUBO) are kept as a fixed proportion of the value
@ of GDP at factor cost (GDPFCV).

GSUBPD=RGSUBPD*GDPFCV;

GSUBO=RGSUBO*GDPFCV;

@ Total subsidies (GSUB)

GSUB=GSUBPD+GSUBO;

@ Total subsidy rate (RGSUB)

RGSUB=GSUB/GDPFCV;

```

@ ----- Transfers -----

@ Income transfers to the unemployed (GTRU) are related to an average  
 @ payment rate per year (RGTRU) and numbers unemployed (U).

GTRU=RGTRU\*U;

@ The average annual rate of unemployment transfer (RGTRU) is indexed to  
 @ annual inflation in average annual non-agricultural earnings (WNA). It can,  
 @ of course, be exogenised in simulations.

\*A

RGTRU = RGTRU(-1) \* (WNA/WNA(-1)) ;

@ The (average) replacement ratio (REPR) is defined as the average  
 @ unemployment transfer rate (RGTRU) relative to average annual earnings  
 @ in the T-sector (WT).

REPR=RGTRU/WT;

@ A large residual category of social welfare transfers (GTRSW), is expressed  
 @ in real (PCONS) per capita (N) terms.

GTRSW = (N\*PCONS) \* RGTRSW;

@ Interest paid on domestic debt (GTRND) is related to an implicit interest  
 @ rate (RGDI) and the stock of debt (GND). Note that this relationship is  
 @ actually used to generate the data for the implicit interest rate (RGDI),  
 @ and is inverted to endogenise the interest payments in the model.

GTRND = (RGDI/100) \* (GND+GND(-1))/2;

@ Total public expenditure on transfers (GTR) consists of unemployment  
 @ transfers (GTRU), social welfare transfers (GTRSW) and national debt  
 @ interest payments (GTRND).

@ -----  
 @ ESF (Social Fund) Structural Funds  
 @ -----

@ The injection of EU funding for training (GTRSFEC) is  
 @ accompanied by a national counterpart (GTRSFDP)

GTRSF=GTRSFEC+GTRSFDP+GTRSFPR;

@ Total (EU+domestic) NSRF expenditure on training (GTRSF) is used to derive  
 @ the number of implied new trainees (SFTRAIN), assuming a trainee/instructor  
 @ ratio (TRATIO), an "overhead" cost ratio (OVERHD), and average annual  
 @ payment rates to trainees (WTRAIN) and instructors (WN).

@  
 @ GTRSF = (SFTRAIN\*WTRAIN+LINS\*WMS)\*(1+OVERHD)

@  
 @ and the identity is solved for SFTRAIN below.

SFTRAIN = (GTRSF/(1.0+OVERHD)) / (WTRAIN+WMS/TRATIO);

@ The wage element of the Social Fund expenditures are defined as SFWAG.

SFWAG=SFTRAIN\*WTRAIN+LINS\*WMS;

@ The number of instructors to be employed is related to  
 @ the number of new SF trainees (SFTRAIN), assuming a

```

@ trainee/instructor ratio of TRATIO.

LINS = SFTRAIN/TRATIO;

@ The average annual payment to a trainee is a fraction of
@ the average annual earnings in the T-sector.

WTRAIN=TMUP*WT;

@ KTRAIN (the stock of trained workers in the private sector of the economy),
@ is only used in the baseline pre-simulation to determine the initial human
@ capital stock. In later simulations, this initial stock appears as the
@ exogenous variable KTRAIN0 (Refer Appendix 1, ESRI (2002))

*P YPLS = 9 ;
*P YHS = 3 ;
*P YNUT = 3 ;
*P YUT = 11 ;

*P FPLS = 0.55 ;
*P FHS = 0.27 ;
*P FNUT = 0.06 ;
*P FUT = 0.12 ;

*P DPLS = 0.0 ;
*P DHS = 1.0 ;
*P DNUT = 1.0 ;
*P DUT = 1.0 ;

KTRAIN=(YPLS*FPLS*DPLS+YHS*FHS*DHS+YNUT*FNUT*DNUT+YUT*FUT*DUT)*LF;

@ Note two variants of equation for KTRAIN0. The second permits the
@ definition of a baseline KTRAIN0 equal to the actual KTRAIN. The first
@ permits one to exogenise KTRAIN0 in NSRF-type simulations.

KTRAIN0=KTRAIN0;
KTRAIN0=KTRAIN;

@ SF trainees are accumulated with a notional "depreciation"
@ rate of 5 per cent.

KSFTRAIN=SFTRAIN+(1-0.05)*KSFTRAIN(-1);

@ The equation for KTRNR calculates the new (increased)
@ ratio of trained workers (relative to the baseline)
@ that arises as a result of the NSRF-funded training schemes.
@ Positive externalities are associated with increases in
@ this ratio relative to an ex-ante baseline (KTRAIN0).

KTRNR=(KTRAIN0+KSFTRAIN)/KTRAIN0;

@ ----- End of ESF section -----

@ Total transfers (GTR)

GTR= GTRU+GTRSW+GTRND+GTRABR+SFTRAIN*WTRAIN;

@ Total public current expenditure on goods and services -----

@ Total public current expenditure (GEC) consists of expenditure on public
@ consumption (GV), subsidies (GSUB), plus transfer payments (GTR).

```

GEC = (GV+GV\_DIF)+GSUB+GTR;

@ Public capital expenditure -----

@ Public capital transfers (GTRKT) are related to an exogenous transfer  
 @ rate (RGTRKT) and the value of T-sector investment (ITV). These are  
 @ mainly investment incentives and should logically appear in the user  
 @ cost of capital formula (PKT).

GTRK=RGTRK\*ITV;

@ Total public infrastructural investment (IGINFV) includes domestic  
 @ (IGV) plus other public investment (commissioned by the G-sector but  
 @ executed by the N-sector) (ISMGV). This distinction may not be  
 @ necessary in all models.

@ -----  
 @ ERDF (Regional Development) Structural Funds  
 @ -----

@ The injection of EU funding for infrastructure (IGVCSFEC)  
 @ is accompanied by a national public counterpart (IGVCSFDP)  
 @ and a private sector amount (IGVCSFPR). We attribute the  
 @ small private element to a notional public sector expenditure  
 @ (IGVCSF) for the purposes of infrastructure accumulation, but  
 @ exclude it from public capital expenditure (GEK) below).

IGVCSF=IGVCSFEC+IGVCSFDP+IGVCSFPR;

@ Total public infrastructural investment (IGINFV) includes  
 @ domestic non-NSRF (IGV) and the purely NSRF expenditures (IGVCSF).

IGINFV=IGV+ISMGV+IGVCSF;

@ Real infrastructural investment (IGINF) is defined by deflating  
 @ nominal investment (IGINFV) by the public investment deflator (PIG).

IGINF = IGINFV/PIG;

@ Infrastructural investment (IGINF) is accumulated into a notional stock  
 @ (KGINF) by a perpetual inventory formula, assuming an DEPGRAT per cent annual  
 @ depreciation rate. At present this is not used elsewhere in the model,  
 @ but can be used in "externality" calculations associated with  
 @ investment aid such as the EU's Structural Funds (see Bradley et al, 1995,  
 @ Regional Aid and Convergence).

KGINF = IGINF + (1-DEPGRAT)\*KGINF(-1);

@ Note two variants of equation for KGINF0. The second permits the  
 @ definition of a baseline KGINF0 equal to the actual KGINF. The first  
 @ permits one to exogenise KGINF0 in NSRF-type simulations.

KGINF0=KGINF0;  
 KGINF0=KGINF;

@ The new (augmented) stock of infrastructure (KGINF) is  
 @ related to a baseline ex-ante stock (KGINF0). Externalities  
 @ are associated with increases in this ratio.

KGINFR=(KGINF/KGINF0);

```

@ ----- End of ERDF section -----

@ -----
@           APS (Aid to Productive Sectors) Structural Funds
@ -----

@ The APS (direct aid to productive sectors) injection of EU funding
@ (TRIEC) is accompanied by a national public counterpart (TRIDP)
@ and a private sector counterpart (TRIPR). Only part of total TRI
@ consists of R&D expenditures (i.e., TRIRD).

@ We accumulate the real TRIRD expenditures (RTRIRD) deflating by the
@ consumption price) to obtain a stock of R&D (KRTRIRD).

@ However, we exclude TRIPR from public NSRF capital expenditure
@ (GEKCSF) below.

@ Define total "real" R&D investment expenditures as the sum of real
@ non-ROP R&D investments (RRANDD) and additional ROP R&D investments
@ (TRIRD/PCONS)

RTRIRD = RRANDD+TRIRD/PCONS;

@ R&D investment is accumulated into a notional stock (KRTRIRD)
@ by a perpetual inventory formula, assuming an 8% depreciation rate.

KRTRIRD = RTRIRD + (1-0.08)*KRTRIRD(-1);

KRTRIRD0= KRTRIRD0;
KRTRIRD0= KRTRIRD;

@ The new (augmented) stock of R&D (KRTRIRD) is related to a baseline
@ ex-ante stock (KRTRIRD0). Spillovers are associated with increases in
@ this ratio (KRTRIRDR).

KRTRIRDR=(KRTRIRD/KRTRIRD0);

@ ----- End of APS/R&D section -----

@ Public capital NSRF expenditure includes both domestic and
@ EU-financed elements of the NSRF infrastructural projects
@ and capital transfers to private sector as production/investment
@ aids.

GEKCSF=(IGVCSF-IGVCSFPR)+(TRIT+TRIMS+TRIA)+(LOCEC+LOC DP);

@ Total expenditure on the EU projects (EC, DP and PR) is GECSFT

GECSFT=IGVCSF+GTRSF+(TRIT+TRITPR)+(TRIMS+TRIMSPR)+(TRIA+TRIAPR)
      +(LOCEC+LOC DP+LOC PR);

@ Expenditure on the EU projects (EC, DP) is GECSFP

GECSFP=IGVCSFEC+IGVCSFDP+GTRSFEC+GTRSFDP+(TRIT)+(TRIMS)+(TRIA)
      +(LOCEC+LOC DP);

@ Expenditure on the EU projects (EC) is GECSFE

GECSFE=IGVCSFEC+GTRSFEC+(TRITEC)+(TRIMSEC)+(TRIAEC)+(LOCEC);

@ An approximate "real" version of GECSFT is GECSFTR

```



```

GECSFTR=GECSFT/PIG;

@ GECSFRAT is the ratio of total expenditure on structural
@ funds (EC, DP and PR) relative to ex-post GDPEV.

GECSFRAT=100*(GECSFT/GDPEV);

@ GECSFRAP is the ratio of public expenditure on structural
@ funds (EC, DP) relative to ex-post GDPEV.

GECSFRAP=100*(GECSFP/GDPEV);

@ GECSFRAE is the ratio of EU expenditure on structural
@ funds (EC) relative to ex-post GDPEV.

GECSFRAE=100*(GECSFE/GDPEV);

@ GECSFRA0 is the ratio of total structural fund
@ expenditure relative to ex-ante GDPEV (i.e., GDPEV0).

GECSFRA0=100*(GECSFT/GDPEV0);

@ Public capital expenditure (GEK) includes public housing investment
@ (IHGV), investment on infrastructure (IGINFV), and production/investment aids
@ paid as capital transfers to industry (GTRKT).

GEK=IHGV+IGINFV+GTRK+GEKCSF;

@ Total government expenditure (current and capital) (GEXP)

GEXP = GEC + GEK;

@ -----
@ --- Tax revenue ---
@ -----

@ ----- Indirect taxation -----

@ Indirect taxation (GTEPD and GTEM) are levied on private consumption (CONSV) at the
@ exogenous implicit rate RGTEPD, and on imports (proxied by GDPFCV) at the exogenous
@ implicit rate RGTEM. For simplicity, excise and VAT revenues are aggregated.

GTEPD=RGTEPD*CONSV;

GTEM=RGTEM*GDPFCV;

@ Total indirect tax revenue (GTE)

GTE = GTEPD+GTEM;

@ ----- Direct taxation -----

@ Direct tax (GTYP) is levied on personal wage income (YW) at
@ the implicit rate RGTYP.

GTYP=RGTYP*YW;

@ Social insurance contributions from employees (GTYSOCW) and from employers
@ (GTYSOCE) is levied on personal wage income (YW) at implicit rates RGTYSOCW
@ and RGTYSOCE, respectively.

```

```

GTYSOCW=RGTYSOCW*YW;
GTYSOCE=RGTYSOCE*YW;
GTYSOC=GTYSOCE+GTYSOCW;
@ Corporation tax (GTYC) is levied on lagged profits (YC) at rate RGTYC.
GTYC=RGTYC*YC(-1);
@ Total tax revenue on income (GTY) is the sum of personal income tax (GTYP),
@ corporation tax (GTYC) and the social insurance contributions (GTYSOC).
GTY=GTYP+GTYC+GTYSOC;
@ ----- Other sources of revenue -----
GREVO=RGREVO*GDPFCV;
@ ----- Tax rate definitions -----
@ Definition of net indirect tax rate (TINC) and the tax wedge (WEDGE), for
@ use elsewhere in the model.
@ TINC, the net indirect tax rate, influences the consumption deflator. It
@ is defined as the difference between the indirect tax rate (RGTE) and
@ the subsidy rate (RGSUB).
TINC=(RGTEPD+RGTEM)-(RGSUBPD+RGSUBO);
@ WEDGE is the tax wedge between the "producer" wage and the take-home,
@ net of indirect tax, "consumer" wage. It combines the effects of
@ direct (RGTYP, RGTYSOCE and RGTYSOCW) and indirect (RGTEPD) tax rates.
WEDGE = (1+RGTYP+RGTYSOCE+RGTYSOCW)*(1+RGTEPD+RGTEM);
@ ----- Transfer receipts from the EC as Structural Funds (CSFTRAN) -----
@ The variable CSFTRAN represents the total EU injection of NSRF aid.
CSFTRAN=(GTRSFEC+IGVCSFEC+TRITEC+TRIMSEC+TRIAEC+LOCEC);
@ The variable CSFTRANR represents the total EU NSRF aid as a
@ percentage of (ex-post) GDPMV.
CSFTRANR=100*(CSFTRAN/GDPMV);
@ From a public accounts viewpoint, the EU NSRF aid is represented as a
@ capital inflow from abroad (CSFTRAN feeding into GREV).
@ ----- Total current revenue -----
@ Total current revenue (GREVC) is the sum of indirect tax (GTE),
@ direct tax (GTY), property tax (GTPROP), and a residual category (GREVO).
GREVC=GTE+GTY+GTYPROP+GREVO + DIFGREVC;
@ ----- Total revenue -----
GREV=GREVC+CSFTRAN+GREVK;

```

```

@ -----
@ ----- Public sector borrowing and debt accumulation -----
@ -----

@ The total borrowing requirement (GBOR) adds the current borrowing
@ requirement (GEC-GREVC) to the capital requirement (GEK-GREVK).

GBOR=(GEC-GREVC)+(GEK-GREVK-CSFTRAN);

@ The primary borrowing requirement (GBORP) nets out interest payments
@ on the national debt (GTRND) from GBOR.

GBORP=(GEC-GTRND-GREVC)+(GEK-GREVK-CSFTRAN);

@ GBORR is the total public sector borrowing requirement (GBOR) expressed as a
@ percentage of GNPV.

GBORR=100*(GBOR/GDPEV);

@ GBORPR is the primary public sector borrowing requirement (GBORP) expressed
@ as a percentage of GNP.

GBORPR=100*(GBORP/GDPEV);

@ A simple process of national debt accumulation is modelled. Annual
@ borrowing (GBOR) is accumulated into a notional debt stock (GND).
@ It is assumed that all borrowing is funded from domestic sources.
@ This will need to be adapted to the situation in each country, but
@ should be kept as simple as possible.

*A
GND = GND(-1) + GBOR;

@ The debt/GDP ratio (RDEBT) is a memo item.

RDEBT=100*GND/GDPEV;

@ -----
@ ----- Private and personal income determination -----
@ -----

@ The definition of gross domestic product at factor cost (GDPFCV)
@ aggregates the five sectoral added-value measures, and adjusts for
@ financial services (YAFS). Note that it is the definition of GDP
@ on the output side (i.e., GDPFCV) that is used to drive the income
@ side of the model.

GDPFCV= (OTV+OBCV+OMSV+OAV+OGV)-YAFS;

@ The adjustment for financial services (YAFS) is linked to GDP (GDPFCV)
@ via a time trend (TYAFS).

*P AYAFS1 = -10.9102 ;
*P AYAFS2 = 1.56071 ;
*P AYAFS3 = -0.064955 ;

*A
YAFS = exp(AYAFS1+AYAFS2*log(GDPFCV)+AYAFS3*TYAFS) ;

@ Definition of GDP at factor cost in real terms.

```

$GDPFC = (OT + OBC + OMS + OA + OG) - YRAFS;$

@ Definition of the deflator of GDP at factor cost (PGDPFC).

$PGDPFC = GDPFCV / GDPFC;$

@ Definition of the adjustment for financial services in real terms (YRAFS).

@ The deflator (PYAFS) was defined in the section on prices above.

$YRAFS = YAFS / PYAFS;$

@ The net indirect tax adjustment (GTE-GSUB) to GDP at factor cost (GDPFCV)

@ is made to define GDP at market prices (GDPMV).

$GDPMV = GDPFCV + (GTEPD - GSUBPD);$

@ A "real" net indirect tax adjustment (TRE-GSRUB) to real GDP at factor

@ cost is made to define real GDP at market prices (GDPM).

$GDPM = GDPFC + (GTREPD - GSRUBPD);$

@ Real indirect taxation and subsidies are linked to notional volume bases.

@ The National Accounting conventions are complex, and this is a

@ simplification of how the deflation is actually handled.

@

@ Indirect taxes (GTEPD) are assumed to be levied entirely on personal

@ consumption (CONS). The ratio is estimated from the sample data.

$GTREPD = RGTEPD * CONS;$

@ Subsidies (GSUBPD) are assumed to apply to GDPFC.

$GSRUBPD = RGSUBPD * GDPFC;$

@ The deflator of GDP at market prices (PGDPM) is recovered from an identity.

$PGDPM = GDPMV / GDPM;$

@ The net factor income from abroad (YFN) adjustment is made to GDP

@ to define GNP. For countries with high FDI and/or foreign debt,

@ (e.g., Luxembourg, Ireland), this is a very large correction, due to

@ foreign debt interest and profit repatriation by foreign multinationals.

@ It may be less relevant to the CEE economies, where GDP and GNP are

@ likely to be very similar in size.

@ Calculation of nominal GNPV.

$GNPV = GDPMV + YFN;$

@ Calculation of real GNP

$GNP = GDPM + YRFN;$

@ The annual growth rate of GNP (GNPDOT) is a useful memo item.

$GNPDOT = 100 * (GNP / GNP(-1) - 1.0);$

@ Per capita GNP is defined (GNPPC).

$GNPPC = GNP / N;$

@ Real net factor income from abroad (YRFN) is deflated using POT.

@ The exogenous variable KYFNX ensures no discrepancy with the National

@ Accounts, where a different convention is used.

$YRFN=YFN/PYFN;$

@ The deflator of GNP is defined (PGNP).

$PGNP=GNPV/GNP;$

@ Total depreciation (DEP) is linked to the value of the total capital stock

$DEP = DEPRAT*(PI*(KT+KMS+KBC+KA+KGINF));$

@ -----  
 @ The following series of National Accounting identities lead to a  
 @ definition of personal disposable income (YPERD) and taxable income (YPERT)  
 @ -----

@ Net (of depreciation) domestic product at factor cost (NDPFCV).

$NDPFCV=GPMV-DEP-(GTEPD-GSUBPD);$

@ Net (of depreciation) national product at factor cost (NNPFCV).

$NNPFCV=NDPFCV+YFN+YASA;$

@ Private sector income (YP) nets out public sector trading income (GTTI),  
 @ but adds in transfers (GTR) and private sector income transfers through  
 @ the current account of the balance of payments (BTPRNE).

$YP=NNPFCV-GTTI+GTR+(SFTRAIN*WTRAIN)+BTPRNE;$

@ Corporate profits (YC) are derived residually.

$YC=NDPFCV-YWA-YWNA+YASA+YAFS;$

@ Undistributed (or retained) profits (YCU) are determined as a fraction (YCURAT)  
 @ of total profits (YC), but may be sensitive to the business cycle (GNPDOT).

$YCU=YCURAT*YC;$

@ Personal income (YPER) is obtained from private income (YP) less  
 @ retained profits (YCU).

$YPER=YP-YCU;$

@ Personal disposable income (YPERD) nets off direct tax revenue (GTYP+GTYSIB)  
 @ from personal income (YPER).

$YPERD=YPER-(GTYP+GTYSOCW);$

@ Real personal disposable income (YRPERD) deflates YPERD using the  
 @ consumption deflator (PCONS).

$YRPERD=YPERD/PCONS;$

@ Real personal disposable income per capita (YRPERDPC).

$YRPERDPC = YRPERD/N;$

@ Non-agricultural wage bill (YWNA) sums the wage bills in the T, N and  
 @ G-sectors.

$YWNA=YWT+YWBC+YWMS+YWG;$

@ Total (economy-wide) wage bill (YW) sums the wage bills in the  
 @ non-ag (YWNA) and ag (YWA) sectors

$YW=YWNA+YWA;$

@ Average annual earnings in the non-agriculture sector (WNA).

$WNA=YWNA/(LTEMP+LBCEMP+LMSEMP+LG);$

@ Annual inflation rate of WNA (WNADOT).

$WNADOT=100*(WNA/WNA(-1))-1;$

@ Total economywide productivity (LPROD)

$LPROD = GDPFC/L ;$

@ -----  
 @ --- Balance of payments and net factor income flows ---  
 @ -----

@ Private net income flows through the current account of the balance of  
 @ payments (YFNPO) are driven by the rate of return (RYFNPO) on assets held  
 @ abroad (NFLP). At present it is exogenous.

@ Balance of trade (NTSV) as a percentage of GNP (NTSVR).

$NTSVR=100*NTSV/GDPEV;$

@ Balance of payments on current account (BP) consists of the balance  
 @ of trade (NTSV), net factor payments from abroad (YFN) and a residual  
 @ item (BPRES).

$BP = NTSV + YFN + BPRES;$

@ Balance of payments as a percentage of GNPV (BPR).

$BPR = 100*BP/GDPEV;$

## E.2: TSP CALIBRATION RESULTS

### E.2.1 JOINT FACTOR DEMAND SYSTEMS FOR T, BC AND MS SECTORS

```

1 ? -----
1 ?
1 ?                      HCZ5JFDPC.TSP
1 ?
1 ? Calibration of joint factor demand systems in manufacturing,
1 ? building and construction, and market services
1 ?
1 ? -----
1
1 OPTIONS LIMWARN=1;
2 IN HCZ5DB;
3
3 ? -----
3 ? -----  MANUFACTURING (T) -----
3 ? -----
3
3 print IT LT OT ERFPT;
4 print IBC LBC OBC ERFPPBC;
5 print IMS LMS OMS ERFPPMS;
6
6 ? Full sample size
6
6 smpl 1995 2004;
7 y1=log(it/lt);
8 x1=log(erfpt);
9 title "CES for manufacturing (unconstrained)";
10 olsq y1 c x1 t;
11 olsq y1 c x1;
12
12 ? -----
12
12 param sigt rhot deltax;
13 set z1=@coef(1);
14 set z2=@coef(2);
15 set sigt = z2;
16 set rhot = (1-sigt)/sigt;
17 set deltax = 1/(1+exp(z1/sigt));
18 print sigt rhot deltax;
19
19
19 temp1=-rhot*log(LT);
20 temp1=exp(temp1);
21 temp2=-rhot*log(IT);
22 temp2=exp(temp2);
23 temp=deltax*temp1+(1-deltax)*temp2;
24 temp=(-1/rhot)*log(temp);
25 temp=exp(temp);
26 y1=log(OT)-log(temp);
27
27 Title "Recover remaining CES parameters (AT, LAMT) for T-sector";

```

```

28  olsq y1 c t;
29  set z3=@coef(1);
30  set z4=@coef(2);
31  param at lamt;
32  set at=exp(z3);
33  set lamt=z4;
34  Title
   "=====";
35  print sigt rhot delat at lamt;
36  Title
   "=====";
37
37  delete z1 z2 z3 z4;
38
38  ? -----
38
38  y1=log(it/lt);
39  x1=log(erfpt);
40
40  ? -----
40  ? Now constrain SIGT to be 0.20 (i.e., near Leontief)
40  ? -----
40
40  set sigt = 0.20;
41  y2=y1-sigt*x1;
42  title "CES for manufacturing: constrained SIGT (0.20)";
43  olsq y2 c;
44  set z1=@coef(1);
45  set rhot = (1-sigt)/sigt;
46  set delat = 1/(1+exp(z1/sigt));
47  print sigt rhot delat;
48
48  temp1=-rhot*log(LT);
49  temp1=exp(temp1);
50  temp2=-rhot*log(IT);
51  temp2=exp(temp2);
52  temp=delat*temp1+(1-delat)*temp2;
53  temp=(-1/rhot)*log(temp);
54  temp=exp(temp);
55
55  y1=log(OT)-log(temp);
56  Title "Recover remaining CES parameters for T-sector: AT, LAMT";
57  olsq y1 c t;
58  set z3=@coef(1);
59  set z4=@coef(2);
60  param at lamt;
61  set at=exp(z3);
62  set lamt=z4;
63  Title
   "=====";
64  print sigt rhot delat at lamt;
65  Title
   "=====";
66
66  delete z1 z2 z3 z4;
67
67  ? -----
67
67  y1=log(it/lt);
68  x1=log(erfpt);
69

```



```

69 ? -----
69 ? Now constrain SIGT to be 0.50 (i.e., between Leontief) and CD
69 ? -----
69
69 set sigt = 0.50;
70 y2=y1-sigt*x1;
71 title "CES for manufacturing: constrained SIGT (0.50)";
72 olsq y2 c;
73 set z1=@coef(1);
74 set rhot = (1-sigt)/sigt;
75 set deltax = 1/(1+exp(z1/sigt));
76 print sigt rhot deltax;
77
78 temp1=-rhot*log(LT);
79 temp1=exp(temp1);
80 temp2=-rhot*log(IT);
81 temp2=exp(temp2);
82 temp=deltax*temp1+(1-deltax)*temp2;
83 temp=(-1/rhot)*log(temp);
84 temp=exp(temp);
85
86 y1=log(OT)-log(temp);
87 Title "Recover remaining CES parameters for T-sector: AT, LAMT";
88 olsq y1 c t;
89 set z3=@coef(1);
90 set z4=@coef(2);
91 param at lamt;
92 set at=exp(z3);
93 set lamt=z4;
94
95 Title
96 "=====";
97 print sigt rhot deltax at lamt;
98 Title
99 "=====";
100
101 delete z1 z2 z3 z4;
102
103 ? -----
104
105 y1=log(it/lt);
106 x1=log(erfpt);
107
108 ? -----
109 ? Now constrain SIGT to be 0.80 (i.e., quasi Cobb-Douglas).
110 ? -----
111
112 set sigt = 0.80;
113 y2=y1-sigt*x1;
114 title "CES for manufacturing: constrained SIGT (0.80)";
115 olsq y2 c;
116 set z1=@coef(1);
117 set rhot = (1-sigt)/sigt;
118 set deltax = 1/(1+exp(z1/sigt));
119 print sigt rhot deltax;
120
121
122 temp1=-rhot*log(LT);
123 temp1=exp(temp1);
124 temp2=-rhot*log(IT);
125 temp2=exp(temp2);
126 temp=deltax*temp1+(1-deltax)*temp2;

```

```

111 temp=(-1/rhot)*log(temp);
112 temp=exp(temp);
113
113 y1=log(OT)-log(temp);
114 Title "Recover remaining CES parameters for T-sector: AT, LAMT";
115 olsq y1 c t;
116 set z3=@coef(1);
117 set z4=@coef(2);
118 param at lamt;
119 set at=exp(z3);
120 set lamt=z4;
121
121 Title
121 "=====";
122 print sigt rhot delt at lamt;
123 Title
123 "=====";
124
124 delete z1 z2 z3 z4;
125
125
125
125 ? -----
125 ? ----- MARKET SERVICES SECTOR (MS) -----
125 ? -----
125
125 y1=log(ims/lms);
126 x1=log(erfpms);
127 title "CES for market services: unconstrained SIGMS";
128 olsq y1 c x1 t;
129 olsq y1 c x1;
130
130 param sigms rhoms delms;
131 set z1=@coef(1);
132 set z2=@coef(2);
133 set sigms = z2;
134 set rhoms = (1-sigms)/sigms;
135 set delms = 1/(1+exp(z1/sigms));
136 print sigms rhoms delms;
137
137 ?
137 ? -----
137 ? Now constrain SIGMS to be 0.50 (i.e., between Cobb-Douglas) and
137 ? Leontief
137 ? -----
137
137 y1=log(ims/lms);
138 x1=log(erfpms);
139
139 set sigms = 0.50;
140 y2=y1-sigms*x1;
141 title "CES for market services: constrained SIGMS (0.50)";
142 olsq y2 c;
143 set z1=@coef(1);
144 set rhoms = (1-sigms)/sigms;
145 set delms = 1/(1+exp(z1/sigms));
146 print sigms rhoms delms;
147
147
147 templ=-rhoms*log(LMS);
148 templ=exp(templ);

```

```

149 temp2=-rhoms*log(IMS);
150 temp2=exp(temp2);
151 temp=delms*temp1+(1-delms)*temp2;
152 temp=(-1/rhoms)*log(temp);
153 temp=exp(temp);
154
154 y1=log(OMS)-log(temp);
155 Title "Recover remaining CES parameters for MS-sector: AMS, LAMMS";
156 olsq y1 c t;
157 set z3=@coef(1);
158 set z4=@coef(2);
159 param ams lamms;
160 set ams=exp(z3);
161 set lamms=z4;
162
162 Title
"=====";
163 print sigms rhoms delms ams lamms;
164 Title
"=====";

165
165 delete z1 z2 z3 z4;
166
166
166 ? -----
166 ? Now constrain SIGMS to be 0.80 (i.e., quasi Cobb-Douglas).
166 ? -----
166
166 y1=log(ims/lms);
167 x1=log(erfpms);
168
168 set sigms = 0.80;
169 y2=y1-sigms*x1;
170 title "CES for market services: constrained SIGMS (0.80)";
171 olsq y2 c;
172 set z1=@coef(1);
173 set rhoms = (1-sigms)/sigms;
174 set delms = 1/(1+exp(z1/sigms));
175 print sigms rhoms delms;
176
176
176 temp1=-rhoms*log(LMS);
177 temp1=exp(temp1);
178 temp2=-rhoms*log(IMS);
179 temp2=exp(temp2);
180 temp=delms*temp1+(1-delms)*temp2;
181 temp=(-1/rhoms)*log(temp);
182 temp=exp(temp);
183
183 y1=log(OMS)-log(temp);
184 Title "Recover remaining CES parameters for ms-sector: AMS, LAMMS";
185 olsq y1 c t;
186 set z3=@coef(1);
187 set z4=@coef(2);
188 param ams lamms;
189 set ams=exp(z3);
190 set lamms=z4;
191
191 Title
"=====";
192 print sigms rhoms delms ams lamms;
193 Title

```

```

"=====";
194
194 delete z1 z2 z3 z4;
195
195
195 ? -----
195 ? ----- BUILDING & CONSTRUCTION SECTOR -----
195 ? -----
195
195 y1=log(IBC/LBC);
196 x1=log(ERFPBC);
197 title "CES for building & construction: unconstrained SIGBC";
198 olsq y1 c x1 t;
199 olsq y1 c x1;
200
200 param sigbc rhobc delbc;
201 set z1=@coef(1);
202 set z2=@coef(2);
203 set sigbc = z2;
204 set rhobc = (1-sigbc)/sigbc;
205 set delbc = 1/(1+exp(z1/sigbc));
206 print sigbc rhobc delbc;
207
207 ?
-----
207 ? Now constrain SIGBC to be 0.50 (i.e., between Cobb-Douglas) and
Leontief
207 ?
-----
207
207 y1=log(IBC/LBC);
208 x1=log(ERFPBC);
209
209 set sigbc = 0.50;
210 y2=y1-sigbc*x1;
211 title "CES for building & construction: constrained SIGBC (0.50)";
212 olsq y2 c;
213 set z1=@coef(1);
214 set rhobc = (1-sigbc)/sigbc;
215 set delbc = 1/(1+exp(z1/sigbc));
216 print sigbc rhobc delbc;
217
217
217 temp1=-rhobc*log(LBC);
218 temp1=exp(temp1);
219 temp2=-rhobc*log(IBC);
220 temp2=exp(temp2);
221 temp=delbc*temp1+(1-delbc)*temp2;
222 temp=(-1/rhobc)*log(temp);
223 temp=exp(temp);
224
224
224 y1=log(OBC)-log(temp);
225 Title "Recover remaining CES parameters for BC-sector: ABC, LAMBC";
226 olsq y1 c t;
227 set z3=@coef(1);
228 set z4=@coef(2);
229 param abc lambc;
230 set abc=exp(z3);
231 set lambc=z4;
232
232 Title
"=====";

```

```

233 print sigbc rhobc delbc abc lambc;
234 Title
    "=====";
235
235 delete z1 z2 z3 z4;
236
236 ? -----
236 ? Now constrain SIGBC to be 0.80 (i.e., quasi Cobb-Douglas).
236 ? -----
236
236 y1=log(IBC/LBC);
237 x1=log(erfpbc);
238
238 set sigbc = 0.80;
239 y2=y1-sigbc*x1;
240 title "CES for building & construction: constrained SIGBC (0.80)";
241 olsq y2 c;
242 set z1=@coef(1);
243 set rhobc = (1-sigbc)/sigbc;
244 set delbc = 1/(1+exp(z1/sigbc));
245 print sigbc rhobc delbc;
246
246
246 temp1=-rhobc*log(LBC);
247 temp1=exp(temp1);
248 temp2=-rhobc*log(IBC);
249 temp2=exp(temp2);
250 temp=delbc*temp1+(1-delbc)*temp2;
251 temp=(-1/rhobc)*log(temp);
252 temp=exp(temp);
253
253 y1=log(OBC)-log(temp);
254 Title "Recover remaining CES parameters for bc-sector: Abc, LAMBC";
255 olsq y1 c t;
256 set z3=@coef(1);
257 set z4=@coef(2);
258 param abc lambc;
259 set abc=exp(z3);
260 set lambc=z4;
261
261 Title
    "=====";
262 print sigbc rhobc delbc abc lambc;
263 Title
    "=====";
264
264 delete z1 z2 z3 z4;
265
265 END ;

```

	IT	LT	OT	ERFPT
1991	.	.	.	.
1992	.	.	.	.
1993	.	.	.	.
1994	.	.	.	.
1995	103004.00000	1366.15100	317380.00000	.
1996	110408.00000	1388.17102	365825.00000	.
1997	116617.00000	1451.30103	379038.00000	1341.27051
1998	108787.00000	1419.54602	344054.00000	1424.73853
1999	110114.00000	1357.18506	387274.00000	1526.10193
2000	130457.00000	1299.92798	405738.00000	1603.19128
2001	136641.00000	1338.13696	392255.00000	1655.09790
2002	132999.00000	1382.04199	434456.00000	1762.61572
2003	138135.00000	1312.70996	466839.00000	1836.87292
2004	146382.00000	1294.18005	497985.00000	1868.86914

	IBC	LBC	OBC	ERFPBC
1991	.	.	.	.
1992	.	.	.	.
1993	.	.	.	.
1994	.	.	.	.
1995	10743.00000	520.87701	125447.00000	.
1996	12422.00000	466.73901	110363.00000	.
1997	18020.00000	483.87399	97136.00000	1216.88269
1998	18547.00000	488.97699	100473.00000	1240.63647
1999	15563.00000	413.40799	78404.00000	1264.57336
2000	15815.00000	419.79800	78141.00000	1333.62122
2001	17477.00000	411.13599	71761.00000	1390.98889
2002	18851.00000	385.61301	74013.00000	1486.63501
2003	17194.00000	416.02802	77751.00000	1427.50342
2004	15752.00000	414.50800	77392.00000	1334.47156

	IMS	LMS	OMS	ERFPMS
1991	.	.	.	.
1992	.	.	.	.
1993	.	.	.	.
1994	.	.	.	.
1995	287539.00000	2140.10303	700863.00000	.
1996	298940.00000	2167.95703	710854.00000	.
1997	293460.00000	2149.23291	705633.00000	1333.93579
1998	306797.00000	2089.10083	735698.00000	1418.94897
1999	297600.00000	2058.46704	728028.00000	1478.87903
2000	288754.00000	2057.64697	757252.00000	1512.02625
2001	300693.00000	2056.05396	812392.00000	1563.98999
2002	314378.00000	2130.97900	793757.00000	1640.75916
2003	339152.00000	2073.41699	794544.00000	1749.59851
2004	355924.00000	2086.72095	852340.00000	1831.17236

Current sample: 1995 to 2004

CES for manufacturing (unconstrained)

=====

Dependent variable: Y1  
 Current sample: 1997 to 2004  
 Number of observations: 8

Mean of dep. var. = 4.53846  
 Std. dev. of dep. var. = .144648

LM het. test = .968786 [.325]  
 Durbin-Watson = 1.95407 [.095, .872]

Sum of squared residuals = .025280      Jarque-Bera test = .673391 [.714]  
 Variance of residuals = .505606E-02      Ramsey's RESET2 = .911706 [.394]  
 Std. error of regression = .071106      F (zero slopes) = 11.9837 [.012]  
    R-squared = .827392      Schwarz B.I.C. = -8.55801  
    Adjusted R-squared = .758348      Log likelihood = 11.6772

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	6.42823	12.0992	.531295	[.618]
X1	-.356506	1.75814	-.202775	[.847]
T	.070885	.085609	.828000	[.445]

Equation 2  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1997 to 2004  
 Number of observations: 8

Mean of dep. var. = 4.53846      LM het. test = 1.37496 [.241]  
 Std. dev. of dep. var. = .144648      Durbin-Watson = 2.08132 [.352, .740]  
 Sum of squared residuals = .028747      Jarque-Bera test = .947697 [.623]  
 Variance of residuals = .479111E-02      Ramsey's RESET2 = .039266 [.851]  
 Std. error of regression = .069218      F (zero slopes) = 24.5692 [.003]  
    R-squared = .803724      Schwarz B.I.C. = -9.08375  
    Adjusted R-squared = .771012      Log likelihood = 11.1632

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-3.49458	1.62081	-2.15606	[.074]
X1	1.08723	.219343	4.95674	[.003]

Value	SIGT	RHOT	DELT
	1.08723	-0.080229	0.96137

Recover remaining CES parameters (AT, LAMT) for T-sector  
 =====

Equation 3  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = 5.46556      LM het. test = .059015 [.808]  
 Std. dev. of dep. var. = .154033      Durbin-Watson = 1.95065 [.306, .633]  
 Sum of squared residuals = .028583      Jarque-Bera test = .813795 [.666]  
 Variance of residuals = .357293E-02      Ramsey's RESET2 = 1.68345 [.236]  
 Std. error of regression = .059774      F (zero slopes) = 51.7649 [.000]  
    R-squared = .866142      Schwarz B.I.C. = -12.7956

Adjusted R-squared = .849410                      Log likelihood = 15.0982

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	5.01575	.065314	76.7949	[.000]
T	.047348	.658090E-02	7.19478	[.000]

```

=====
=====
Value          SIGT          RHOT          DELT          AT          LAMT
=====
Value          1.08723        -0.080229     0.96137       150.76895    0.047348
=====
=====

```

=====  
CES for manufacturing: constrained SIGT (0.20)  
=====

Equation 4  
=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y2  
Current sample: 1997 to 2004  
Number of observations: 8

Mean of dep. var. = 3.06075	LM het. test = 0. [1.00]
Std. dev. of dep. var. = .123714	Durbin-Watson = .589163 [.006,.006]
Sum of squared residuals = .107136	Jarque-Bera test = .800561 [.670]
Variance of residuals = .015305	Ramsey's RESET2 = .850706E+38 [.000]
Std. error of regression = .123714	Schwarz B.I.C. = -4.86116
R-squared = 0.	Log likelihood = 5.90088
Adjusted R-squared = 0.	

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	3.06075	.043739	69.9767	[.000]

```

Value          SIGT          RHOT          DELT
Value          0.20000        4.00000     2.25772D-07

```

=====  
Recover remaining CES parameters for T-sector: AT, LAMT  
=====

Equation 5  
=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
Current sample: 1995 to 2004  
Number of observations: 10



Mean of dep. var. = 1.86604                      LM het. test = .025250 [.874]  
 Std. dev. of dep. var. = .152717                Durbin-Watson = 1.90834 [.281, .605]  
 Sum of squared residuals = .028446              Jarque-Bera test = .814458 [.665]  
 Variance of residuals = .355570E-02          Ramsey's RESET2 = 1.86043 [.215]  
 Std. error of regression = .059630              F (zero slopes) = 51.0323 [.000]  
    Schwarz B.I.C. = -12.8198  
 Adjusted R-squared = .847541                    Log likelihood = 15.1223

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	1.42050	.065156	21.8016	[.000]
T	.046898	.656502E-02	7.14369	[.000]

```

=====
=====
Value          SIGT          RHOT          DELT          AT          LAMT
=====
Value          0.20000         4.00000         2.25772D-07         4.13919         0.046898
=====
=====
  
```

CES for manufacturing: constrained SIGT (0.50)  
 =====

Equation 6  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y2  
 Current sample: 1997 to 2004  
 Number of observations: 8

Mean of dep. var. = .844182                      LM het. test = 0. [1.00]  
 Std. dev. of dep. var. = .094934                Durbin-Watson = .933272 [.041, .041]  
 Sum of squared residuals = .063087              Jarque-Bera test = .777170 [.678]  
 Variance of residuals = .901238E-02          Ramsey's RESET2 = .850706E+38 [.000]  
 Std. error of regression = .094934              Schwarz B.I.C. = -6.97952  
    Log likelihood = 8.01924  
 Adjusted R-squared = 0.

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	.844182	.033564	25.1514	[.000]

```

Value          SIGT          RHOT          DELT
Value          0.50000         1.00000         0.15599
  
```

Recover remaining CES parameters for T-sector: AT, LAMT  
 =====

Equation 7

=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
Current sample: 1995 to 2004  
Number of observations: 10

Mean of dep. var. = 3.87420	LM het. test = .049667 [.824]
Std. dev. of dep. var. = .153809	Durbin-Watson = 1.94022 [.300, .626]
Sum of squared residuals = .028585	Jarque-Bera test = .813032 [.666]
Variance of residuals = .357317E-02	Ramsey's RESET2 = 1.72548 [.230]
Std. error of regression = .059776	F (zero slopes) = 51.5873 [.000]
R-squared = .865743	Schwarz B.I.C. = -12.7953
Adjusted R-squared = .848961	Log likelihood = 15.0978

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	3.42515	.065316	52.4399	[.000]
T	.047268	.658112E-02	7.18243	[.000]

```

=====
=====
Value          SIGT          RHOT          DELT          AT          LAMT
=====
Value          0.50000         1.00000         0.15599         30.72720         0.047268
=====
=====

```

CES for manufacturing: constrained SIGT (0.80)

Equation 8

=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y2  
Current sample: 1997 to 2004  
Number of observations: 8

Mean of dep. var. = -1.37238	LM het. test = 0. [1.00]
Std. dev. of dep. var. = .072666	Durbin-Watson = 1.56464 [.255, .255]
Sum of squared residuals = .036962	Jarque-Bera test = .778155 [.678]
Variance of residuals = .528033E-02	Ramsey's RESET2 = .850706E+38 [.000]
Std. error of regression = .072666	Schwarz B.I.C. = -9.11797
R-squared = 0.	Log likelihood = 10.1577
Adjusted R-squared = 0.	

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-1.37238	.025691	-53.4183	[.000]

```

Value          SIGT          RHOT          DELT
Value          0.80000         0.25000         0.84755

```

Recover remaining CES parameters for T-sector: AT, LAMT  
 =====

Equation 9  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = 5.23876	LM het. test = .055837 [.813]
Std. dev. of dep. var. = .153974	Durbin-Watson = 1.94750 [.304, .631]
Sum of squared residuals = .028587	Jarque-Bera test = .813494 [.666]
Variance of residuals = .357336E-02	Ramsey's RESET2 = 1.69604 [.234]
Std. error of regression = .059778	F (zero slopes) = 51.7115 [.000]
R-squared = .866022	Schwarz B.I.C. = -12.7950
Adjusted R-squared = .849275	Log likelihood = 15.0976

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	4.78915	.065317	73.3212	[.000]
T	.047327	.658130E-02	7.19107	[.000]

```

=====
=====
Value          SIGT          RHOT          DELT          AT          LAMT
=====
                0.80000         0.25000         0.84755        120.19965        0.047327
=====
=====

```

CES for market services: unconstrained SIGMS  
 =====

Equation 10  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1997 to 2004  
 Number of observations: 8

Mean of dep. var. = 5.00495	LM het. test = 1.73576 [.188]
Std. dev. of dep. var. = .075359	Durbin-Watson = 1.92884 [.087, .861]
Sum of squared residuals = .231166E-02	Jarque-Bera test = 1.03989 [.595]
Variance of residuals = .462332E-03	Ramsey's RESET2 = 2.33195 [.201]
Std. error of regression = .021502	F (zero slopes) = 40.4914 [.001]
R-squared = .941849	Schwarz B.I.C. = -18.1263
Adjusted R-squared = .918588	Log likelihood = 21.2454

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-14.5428	4.44994	-3.26809	[.022]
X1	2.79313	.644886	4.33120	[.007]
T	-.093884	.027917	-3.36301	[.020]

Equation 11

=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1997 to 2004  
 Number of observations: 8

Mean of dep. var. = 5.00495	LM het. test = .026799 [ .870]
Std. dev. of dep. var. = .075359	Durbin-Watson = 1.28747 [ .042, .261]
Sum of squared residuals = .754055E-02	Jarque-Bera test = .629043 [ .730]
Variance of residuals = .125676E-02	Ramsey's RESET2 = 3.88329 [ .106]
Std. error of regression = .035451	F (zero slopes) = 25.6310 [ .002]
R-squared = .810313	Schwarz B.I.C. = -14.4367
Adjusted R-squared = .778698	Log likelihood = 16.5161

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	.301920	.929039	.324981	[.756]
X1	.639742	.126364	5.06271	[.002]

Value	SIGMS	RHOMS	DELMS
	0.63974	0.56313	0.38416

CES for market services: constrained SIGMS (0.50)

=====

Equation 12

=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y2  
 Current sample: 1997 to 2004  
 Number of observations: 8

Mean of dep. var. = 1.32922	LM het. test = -.302082E-02 [1.00]
Std. dev. of dep. var. = .036011	Durbin-Watson = 1.21168 [ .109, .109]
Sum of squared residuals = .907750E-02	Jarque-Bera test = .671331 [ .715]
Variance of residuals = .129679E-02	Ramsey's RESET2 = .850706E+38 [ .000]
Std. error of regression = .036011	Schwarz B.I.C. = -14.7344
R-squared = 0.	Log likelihood = 15.7741
Adjusted R-squared = 0.	

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	1.32922	.012732	104.402	[.000]

	SIGMS	RHOMS	DELMS
--	-------	-------	-------

Value            0.50000            1.00000            0.065470

Recover remaining CES parameters for MS-sector: AMS, LAMMS  
 =====

Equation 13  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = 3.25497	LM het. test = .518647 [.471]
Std. dev. of dep. var. = .074188	Durbin-Watson = 2.13561 [.424, .744]
Sum of squared residuals = .635190E-02	Jarque-Bera test = .931261 [.628]
Variance of residuals = .793987E-03	Ramsey's RESET2 = .094474 [.768]
Std. error of regression = .028178	F (zero slopes) = 54.3873 [.000]
R-squared = .871769	Schwarz B.I.C. = -20.3160
Adjusted R-squared = .855740	Log likelihood = 22.6186

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	3.03762	.030789	98.6588	[.000]
T	.022879	.310227E-02	7.37477	[.000]

=====

Value	SIGMS	RHOMS	DELMS	AMS	LAMMS
	0.50000	1.00000	0.065470	20.85560	0.022879

=====

CES for market services: constrained SIGMS (0.80)  
 =====

Equation 14  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y2  
 Current sample: 1997 to 2004  
 Number of observations: 8

Mean of dep. var. = -.876210	LM het. test = 0. [1.00]
Std. dev. of dep. var. = .036959	Durbin-Watson = .939218 [.042, .042]
Sum of squared residuals = .956194E-02	Jarque-Bera test = .324455 [.850]
Variance of residuals = .136599E-02	Ramsey's RESET2 = .850706E+38 [.000]
Std. error of regression = .036959	Schwarz B.I.C. = -14.5264

R-squared = 0.                      Log likelihood = 15.5661  
 Adjusted R-squared = 0.

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-.876210	.013067	-67.0547	[.000]

Value	SIGMS	RHOMS	DELMS
	0.80000	0.25000	0.74937

Recover remaining CES parameters for ms-sector: AMS, LAMMS  
 =====

Equation 15  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = 5.10107	LM het. test = .515578 [.473]
Std. dev. of dep. var. = .074181	Durbin-Watson = 2.13210 [.422, .742]
Sum of squared residuals = .636270E-02	Jarque-Bera test = .951653 [.621]
Variance of residuals = .795338E-03	Ramsey's RESET2 = .103799 [.757]
Std. error of regression = .028202	F (zero slopes) = 54.2692 [.000]
R-squared = .871526	Schwarz B.I.C. = -20.3075
Adjusted R-squared = .855466	Log likelihood = 22.6101

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	4.88377	.030815	158.485	[.000]
T	.022873	.310491E-02	7.36676	[.000]

=====

Value	SIGMS	RHOMS	DELMS	AMS	LAMMS
	0.80000	0.25000	0.74937	132.12810	0.022873

=====

CES for building & construction: unconstrained SIGBC  
 =====

Equation 16  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1997 to 2004

Number of observations: 8

Mean of dep. var. = 3.68859	LM het. test = .947256 [.330]
Std. dev. of dep. var. = .094749	Durbin-Watson = 2.33591 [.274, .970]
Sum of squared residuals = .897526E-02	Jarque-Bera test = .960250 [.619]
Variance of residuals = .179505E-02	Ramsey's RESET2 = 12.5721 [.024]
Std. error of regression = .042368	F (zero slopes) = 15.0041 [.008]
R-squared = .857177	Schwarz B.I.C. = -12.7002
Adjusted R-squared = .800047	Log likelihood = 15.8194

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-8.51677	2.51893	-3.38111	[.020]
X1	1.72675	.361690	4.77411	[.005]
T	-.020975	.010387	-2.01928	[.099]

Equation 17

=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
Current sample: 1997 to 2004  
Number of observations: 8

Mean of dep. var. = 3.68859	LM het. test = 3.06532 [.080]
Std. dev. of dep. var. = .094749	Durbin-Watson = 1.74034 [.177, .539]
Sum of squared residuals = .016295	Jarque-Bera test = .524048 [.769]
Variance of residuals = .271576E-02	Ramsey's RESET2 = 12.8829 [.016]
Std. error of regression = .052113	F (zero slopes) = 17.1396 [.006]
R-squared = .740704	Schwarz B.I.C. = -11.3545
Adjusted R-squared = .697488	Log likelihood = 13.4339

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-4.65287	2.01493	-2.30920	[.060]
X1	1.15919	.279997	4.14000	[.006]

Value	SIGBC	RHOBC	DELBC
	1.15919	-0.13733	0.98226

CES for building & construction: constrained SIGBC (0.50)

=====

Equation 18

=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y2  
Current sample: 1997 to 2004  
Number of observations: 8

Mean of dep. var. = .090615	LM het. test = -.112144E-02 [1.00]
Std. dev. of dep. var. = .066919	Durbin-Watson = 1.48800 [.218, .218]
Sum of squared residuals = .031347	Jarque-Bera test = 3.06900 [.216]
Variance of residuals = .447813E-02	Ramsey's RESET2 = .850706E+38 [.000]
Std. error of regression = .066919	Schwarz B.I.C. = -9.77709
R-squared = 0.	Log likelihood = 10.8168

Adjusted R-squared = 0.

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	.090615	.023659	3.83000	[.006]

Value	SIGBC	RHOBC	DELBC
	0.50000	1.00000	0.45482

Recover remaining CES parameters for BC-sector: ABC, LAMBC  
=====

Equation 19  
=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
Current sample: 1995 to 2004  
Number of observations: 10

Mean of dep. var. = 4.53874	LM het. test = .552397 [.457]
Std. dev. of dep. var. = .114100	Durbin-Watson = 1.10606 [.018,.121]
Sum of squared residuals = .039739	Jarque-Bera test = 1.13107 [.568]
Variance of residuals = .496741E-02	Ramsey's RESET2 = 18.6766 [.003]
Std. error of regression = .070480	F (zero slopes) = 15.5876 [.004]
R-squared = .660839	Schwarz B.I.C. = -11.1480
Adjusted R-squared = .618444	Log likelihood = 13.4506

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	4.82978	.077012	62.7150	[.000]
T	-.030636	.775958E-02	-3.94812	[.004]

=====

Value	SIGBC	RHOBC	DELBC	ABC	LAMBC
	0.50000	1.00000	0.45482	125.18341	-0.030636

=====

CES for building & construction: constrained SIGBC (0.80)  
=====

Equation 20  
=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y2  
Current sample: 1997 to 2004  
Number of observations: 8

Mean of dep. var. = -2.06817	LM het. test = 0. [1.00]
Std. dev. of dep. var. = .054463	Durbin-Watson = 1.76285 [.361,.361]



Sum of squared residuals = .020764      Jarque-Bera test = 1.67991 [.432]  
 Variance of residuals = .296625E-02      Ramsey's RESET2 = .850706E+38 [.000]  
 Std. error of regression = .054463      Schwarz B.I.C. = -11.4247  
    R-squared = 0.      Log likelihood = 12.4644  
    Adjusted R-squared = 0.

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-2.06817	.019256	-107.406	[.000]

Value	SIGBC	RHOBC	DELBC
	0.80000	0.25000	0.92990

Recover remaining CES parameters for bc-sector: Abc, LAMBC  
 =====

Equation 21  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = 5.12364      LM het. test = .439483 [.507]  
 Std. dev. of dep. var. = .112503      Durbin-Watson = 1.12441 [.020, .129]  
 Sum of squared residuals = .038518      Jarque-Bera test = 1.11893 [.572]  
 Variance of residuals = .481478E-02      Ramsey's RESET2 = 18.0227 [.004]  
 Std. error of regression = .069389      F (zero slopes) = 15.6589 [.004]  
    R-squared = .661861      Schwarz B.I.C. = -11.3041  
    Adjusted R-squared = .619593      Log likelihood = 13.6067

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	5.41082	.075819	71.3648	[.000]
T	-.030230	.763944E-02	-3.95713	[.004]

=====

Value	SIGBC	RHOBC	DELBC	ABC	LAMBC
	0.80000	0.25000	0.92990	223.81596	-0.030230

=====

## E.2.2 CALIBRATION RESULTS FOR SECTORAL OUTPUT EQUATIONS (OT, OBC AND OMS)

```

1 ? -----
1 ? -----  HCZ5CALIB_OT_OBC_OMS.TSP  -----
1 ? -----
1
1 ? -----
1 ? --- Quick re-calibration of  OT, OBC & OMS  ---
1 ? -----
1
1 OPTIONS LIMERR=10 LIMWARN=1 LIMWNUMC=1;
2
2 IN HCZ5DB;
3
3 ? -----
3 ? OT: GDP arising in manufacturing sector -
3 ? -----
3
3 SMPL 1995 2004;
4 print OT, OW, FDOT, ULCT, POT, PWORLD, t;
5
5 y1=log(OT/OW);
6 x1=log(FDOT);
7 x2=log(PCOMPT);
8 x3=log(RULCT);
9
9 Title " log(OT/OW) on log(FDOT) & log(PCOMPT): OLSQ";
10  olsq y1 c x1 x2 ;
11 Title " log(OT/OW) on log(FDOT) & log(PCOMPT) & t: OLSQ";
12  olsq y1 c x1 x2 t ;
13 Title " log(OT/OW) on log(FDOT) & log(RULCT): OLSQ";
14  olsq y1 c x1 x3 ;
15 Title " log(OT/OW) on log(FDOT) & log(RULCT) & t: OLSQ";
16  olsq y1 c x1 x3 t ;
17
17 y1=log(OT);
18 x1=log(OW);
19 x2=log(FDOT);
20 x3=log(PCOMPT);
21 x4=log(RULCT);
22
22 Title " OT on OW, FDOT, PCOMPT, RULCT & T: OLSQ";
23  olsq y1 c x1 x2 x3 x4 t ;
24  y2=y1-0.5*x1-0.5*x2;
25 Title " OT on OW(0.5), FDOT(0.5), PCOMPT(0.0), RULCT & T: OLSQ";
26  olsq y2 c x4 t ;
27  y3=y2+0.3*x3+0.3*x4;
28 Title " OT on OW(0.5), FDOT(0.5), PCOMPT(0.3), RULCT(0.3) & T: OLSQ";
29  olsq y2 c t ;
30
30
30
30 ?-----
30 ? OBC: GDP arising in building & construction  -----
30 ?-----
30
30 smpl 1995 2004;

```

```

31
31 print OBC, IBCTOT, ULCBC, PCONS, t;
32 OBCRAT=OBC/IBCTOT;
33 print OBCRAT;
34
34 y1=log(OBC);
35 x1=log(IBCTOT);
36 x2=log(ULCBC/POBC);
37
37 title " OBC on IBCTOT, ULCBC/POBC and t: log-linear";
38 ols y1 c x1 x2 t ;
39 title " OBC on IBCTOT and ULCBC/POBC: log-linear";
40 ols y1 c x1 x2 ;
41 title " OBC on IBCTOT and t: log-linear";
42 ols y1 c x1 t ;
43 title " OBC on IBCTOT: log-linear";
44 ols y1 c x1 ;
45
45 y2=log(OBC/IBCTOT);
46
46 Title "ZZZZZZ log(OBC/IBCTOT), regressed on competitiveness and t";
47 olsq y2 c x2 t;
48 Title " log(OBC/IBCTOT), regressed on competitiveness";
49 olsq y2 c x2;
50 Title " log(OBC/IBCTOT), regressed on t";
51 olsq y2 c t;
52 Title " log(OBC/IBCTOT), regressed on intercept";
53 olsq y2 c;
54
54
54 ?-----
54 ? OMS: GDP arising in market services -----
54 ?-----
54
54 smpl 1995 2004;
55
55 print OMS, FDOMS, ULCMS, PCONS, t;
56
56 y1=log(OMS);
57 x1=log(FDOMS);
58 x2=log(ULCMS/POMS);
59
59 title " OMS on FDOMS: log-linear";
60 ols y1 c x1 ;
61 title " OMS on FDOMS and t: log-linear";
62 ols y1 c x1 t ;
63 title " OMS on FDOMS and ULCMS/POMS: log-linear";
64 ols y1 c x1 x2 ;
65 title " OMS on FDOMS, ULCMS/POMS and t: log-linear";
66 ols y1 c x1 x2 t ;
67
67 y2=y1-1.000*x1;
68
68 title " OMS on FDOMS (1.00) and ULCMS/POMS: log-linear";
69 ols y2 c x2 ;
70 title " OMS on FDOMS (1.00), ULCMS/POMS and t: log-linear";
71 ols y2 c x2 t ;
72
72 y2=log(OMS/FDOMS);
73 Title "ZZZZZZ log(OMS/FDOMS) on ULCMS/POMS and t";
74 olsq y2 c x2 t;

```

75  
75  
75 END

Current sample: 1991 to 2004  
Current sample: 1995 to 2004

	OT	OW	FDOT	ULCT
1995	317380.00000	1.00000	156496.64063	0.54515
1996	365825.00000	1.00343	169137.62500	0.56370
1997	379038.00000	1.04175	168078.37500	0.62082
1998	344054.00000	1.08167	165938.40625	0.74017
1999	387274.00000	1.10608	165672.39063	0.67852
2000	405738.00000	1.16949	171597.34375	0.65464
2001	392255.00000	1.17083	177986.64063	0.73523
2002	434456.00000	1.16456	183404.96875	0.71343
2003	466839.00000	1.17103	191848.15625	0.66678
2004	497985.00000	1.20495	199495.84375	0.66064

	POT	PWORLD	T
1995	1.00001	1.00000	5.00000
1996	1.08560	0.98328	6.00000
1997	1.15502	1.03045	7.00000
1998	1.29832	1.02751	8.00000
1999	1.28560	1.04876	9.00000
2000	1.27970	1.07123	10.00000
2001	1.35484	1.05365	11.00000
2002	1.31173	0.94697	12.00000
2003	1.28126	0.97403	13.00000
2004	1.31683	0.99475	14.00000

log(OT/OW) on log(FDOT) & log(PCOMPT): OLSQ  
=====

Equation 1  
=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
Current sample: 1995 to 2004  
Number of observations: 10

Mean of dep. var. = 12.7851	LM het. test = 1.48208 [.223]
Std. dev. of dep. var. = .087399	Durbin-Watson = 2.50686 [.490, .975]
Sum of squared residuals = .013826	Jarque-Bera test = .431343 [.806]
Variance of residuals = .197519E-02	Ramsey's RESET2 = .069101 [.801]
Std. error of regression = .044443	F (zero slopes) = 13.9026 [.004]
R-squared = .798881	Schwarz B.I.C. = -15.2756
Adjusted R-squared = .741419	Log likelihood = 18.7294

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-3.98288	3.79177	-1.05040	[.328]
X1	1.39533	.317117	4.40004	[.003]
X2	-.374383	.235834	-1.58748	[.156]

log(OT/OW) on log(FDOT) & log(PCOMPT) & t: OLSQ  
 =====

Equation 2  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = 12.7851	LM het. test = 2.03754 [.153]
Std. dev. of dep. var. = .087399	Durbin-Watson = 2.72016 [.431,1.00]
Sum of squared residuals = .012866	Jarque-Bera test = .113564 [.945]
Variance of residuals = .214433E-02	Ramsey's RESET2 = .140878E-04 [.997]
Std. error of regression = .046307	F (zero slopes) = 8.68663 [.013]
R-squared = .812850	Schwarz B.I.C. = -14.4842
Adjusted R-squared = .719275	Log likelihood = 19.0894

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-7.73761	6.86208	-1.12759	[.303]
X1	1.71397	.579555	2.95738	[.025]
X2	-.204531	.353270	-.578966	[.584]
T	-.013105	.019583	-.669214	[.528]

log(OT/OW) on log(FDOT) & log(RULCT): OLSQ  
 =====

Equation 3  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = 12.7851	LM het. test = .060892 [.805]
Std. dev. of dep. var. = .087399	Durbin-Watson = 1.78797 [.088,.714]
Sum of squared residuals = .011673	Jarque-Bera test = .314768 [.854]
Variance of residuals = .166751E-02	Ramsey's RESET2 = .046638 [.836]
Std. error of regression = .040835	F (zero slopes) = 17.1137 [.002]
R-squared = .830210	Schwarz B.I.C. = -16.1222
Adjusted R-squared = .781698	Log likelihood = 19.5761

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	2.95425	2.47654	1.19289	[.272]
X1	.767875	.216208	3.55156	[.009]
X3	-.890751	.430727	-2.06802	[.077]

log(OT/OW) on log(FDOT) & log(RULCT) & t: OLSQ  
 =====

Equation 4  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = 12.7851	LM het. test = .571658 [.450]
Std. dev. of dep. var. = .087399	Durbin-Watson = 2.52633 [.283,1.00]
Sum of squared residuals = .865889E-02	Jarque-Bera test = .547100 [.761]
Variance of residuals = .144315E-02	Ramsey's RESET2 = .175009 [.693]
Std. error of regression = .037989	F (zero slopes) = 13.8790 [.004]
R-squared = .874047	Schwarz B.I.C. = -16.4642
Adjusted R-squared = .811071	Log likelihood = 21.0694

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-4.79226	5.83472	-.821335	[.443]
X1	1.42960	.500143	2.85839	[.029]
X3	-.759175	.410918	-1.84751	[.114]
T	-.016560	.011459	-1.44509	[.199]

OT on OW, FDOT, PCOMPT, RULCT & T: OLSQ  
 =====

Equation 5  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = 12.8886	LM het. test = .858241 [.354]
Std. dev. of dep. var. = .135937	Durbin-Watson = 2.84623 [.060,1.00]
Sum of squared residuals = .387948E-02	Jarque-Bera test = 3.84443 [.146]
Variance of residuals = .969870E-03	Ramsey's RESET2 = .434156 [.557]
Std. error of regression = .031143	F (zero slopes) = 33.4952 [.002]
R-squared = .976673	Schwarz B.I.C. = -18.1761
Adjusted R-squared = .947515	Log likelihood = 25.0838

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	8.02096	7.94931	1.00901	[.370]
X1	-.739861	.856238	-.864084	[.436]
X2	.309930	.685185	.452330	[.674]
X3	.307379	.322040	.954475	[.394]
X4	-1.27940	.472065	-2.71023	[.054]
T	.035246	.033546	1.05067	[.353]

OT on OW(0.5), FDOT(0.5), PCOMPT(0.0), RULCT & T: OLSQ  
 =====

Equation 6  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y2  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = 6.80191	LM het. test = .209361 [.647]
Std. dev. of dep. var. = .075174	Durbin-Watson = 1.80808 [.094, .726]
Sum of squared residuals = .885927E-02	Jarque-Bera test = .318453 [.853]
Variance of residuals = .126561E-02	Ramsey's RESET2 = .092173 [.772]
Std. error of regression = .035575	F (zero slopes) = 16.5929 [.002]
R-squared = .825809	Schwarz B.I.C. = -17.5011
Adjusted R-squared = .776040	Log likelihood = 20.9550

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	6.01758	.208149	28.9100	[.000]
X4	-1.02948	.350942	-2.93347	[.022]
T	.014102	.431571E-02	3.26763	[.014]

OT on OW(0.5), FDOT(0.5), PCOMPT(0.3), RULCT(0.3) & T: OLSQ  
 =====

Equation 7  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y2  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = 6.80191	LM het. test = .588330 [.443]
Std. dev. of dep. var. = .075174	Durbin-Watson = 2.15151 [.435, .753]
Sum of squared residuals = .019750	Jarque-Bera test = .774226 [.679]
Variance of residuals = .246877E-02	Ramsey's RESET2 = .884038 [.378]
Std. error of regression = .049687	F (zero slopes) = 12.6011 [.008]
R-squared = .611672	Schwarz B.I.C. = -14.6439
Adjusted R-squared = .563131	Log likelihood = 16.9465

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	6.61744	.054291	121.887	[.000]
T	.019419	.547033E-02	3.54981	[.008]

Current sample: 1995 to 2004

OBC            IBCTOT            ULCBC            PCONS            T

1995	125447.00000	191113.98438	0.50642	1.00000	5.00000
1996	110363.00000	210874.70313	0.57208	1.07427	6.00000
1997	97136.00000	215721.10938	0.68821	1.16690	7.00000
1998	100473.00000	219678.59375	0.69468	1.26792	8.00000
1999	78404.00000	189853.25000	0.81364	1.30044	9.00000
2000	78141.00000	206062.51563	0.82002	1.33985	10.00000
2001	71761.00000	227451.06250	0.91027	1.38626	11.00000
2002	74013.00000	237701.06250	0.86388	1.39653	12.00000
2003	77751.00000	253139.75000	0.90935	1.42158	13.00000
2004	77392.00000	272304.90625	0.98010	1.45303	14.00000

	OBCRAT
1995	0.65640
1996	0.52336
1997	0.45029
1998	0.45736
1999	0.41297
2000	0.37921
2001	0.31550
2002	0.31137
2003	0.30715
2004	0.28421

OBC on IBCTOT, ULCBC/POBC and t: log-linear  
 =====

Equation 8  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = 11.3800	LM het. test = .150993E-02 [.969]
Std. dev. of dep. var. = .192902	Durbin-Watson = 1.17884 [.000, .486]
Sum of squared residuals = .025260	Jarque-Bera test = .671997 [.715]
Variance of residuals = .420994E-02	Ramsey's RESET2 = 8.71971 [.032]
Std. error of regression = .064884	F (zero slopes) = 24.5166 [.001]
R-squared = .924576	Schwarz B.I.C. = -11.1111
Adjusted R-squared = .886863	Log likelihood = 15.7163

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	.326359	3.91680	.083323	[.936]
X1	.914370	.330588	2.76589	[.033]
X2	-1.10007	.639905	-1.71912	[.136]
T	-.107483	.016943	-6.34389	[.001]

OBC on IBCTOT and ULCBC/POBC: log-linear  
 =====

Equation 9



=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = 11.3800	LM het. test = 1.83282 [.176]
Std. dev. of dep. var. = .192902	Durbin-Watson = 1.41711 [.017, .454]
Sum of squared residuals = .194688	Jarque-Bera test = .507172 [.776]
Variance of residuals = .027813	Ramsey's RESET2 = .640338 [.454]
Std. error of regression = .166771	F (zero slopes) = 2.52065 [.150]
R-squared = .418667	Schwarz B.I.C. = -2.05144
Adjusted R-squared = .252572	Log likelihood = 5.50532

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	12.9339	8.67520	1.49090	[.180]
X1	-.024429	.759822	-.032151	[.975]
X2	1.67652	1.19985	1.39727	[.205]

OBC on IBCTOT and t: log-linear

=====

Equation 10

=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = 11.3800	LM het. test = 1.49656 [.221]
Std. dev. of dep. var. = .192902	Durbin-Watson = 1.46348 [.021, .488]
Sum of squared residuals = .037701	Jarque-Bera test = .141779 [.932]
Variance of residuals = .538593E-02	Ramsey's RESET2 = 2.00367 [.207]
Std. error of regression = .073389	F (zero slopes) = 27.5903 [.000]
R-squared = .887425	Schwarz B.I.C. = -10.2599
Adjusted R-squared = .855260	Log likelihood = 13.7138

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-.429421	4.40221	-.097546	[.925]
X1	1.02723	.366474	2.80301	[.026]
T	-.087562	.013980	-6.26334	[.000]

OBC on IBCTOT: log-linear

=====

Equation 11

=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = 11.3800	LM het. test = 7.51389 [.006]
Std. dev. of dep. var. = .192902	Durbin-Watson = .710600 [.001, .020]
Sum of squared residuals = .248988	Jarque-Bera test = .793181 [.673]
Variance of residuals = .031124	Ramsey's RESET2 = .704409E-02 [.935]
Std. error of regression = .176419	F (zero slopes) = 2.76034 [.135]
R-squared = .256529	Schwarz B.I.C. = -1.97270
Adjusted R-squared = .163595	Log likelihood = 4.27528

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	21.7901	6.26601	3.47750	[.008]
X1	-.845929	.509159	-1.66143	[.135]

ZZZZZZ log(OBC/IBCTOT), regressed on competitiveness and t  
 =====

Equation 12  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y2  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = -.926150	LM het. test = .124648 [.724]
Std. dev. of dep. var. = .270406	Durbin-Watson = 1.27234 [.007, .348]
Sum of squared residuals = .025542	Jarque-Bera test = .756812 [.685]
Variance of residuals = .364888E-02	Ramsey's RESET2 = 6.26152 [.046]
Std. error of regression = .060406	F (zero slopes) = 86.6747 [.000]
R-squared = .961186	Schwarz B.I.C. = -12.2068
Adjusted R-squared = .950097	Log likelihood = 15.6607

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-.684148	.325082	-2.10454	[.073]
X2	-1.06716	.583876	-1.82771	[.110]
T	-.109448	.014105	-7.75959	[.000]

log(OBC/IBCTOT), regressed on competitiveness  
 =====

Equation 13  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y2

Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = -.926150	LM het. test = 1.63596 [.201]
Std. dev. of dep. var. = .270406	Durbin-Watson = 1.82272 [.234, .548]
Sum of squared residuals = .245246	Jarque-Bera test = .494092 [.781]
Variance of residuals = .030656	Ramsey's RESET2 = .159789E-03 [.990]
Std. error of regression = .175088	F (zero slopes) = 13.4666 [.006]
R-squared = .627328	Schwarz B.I.C. = -2.04843
Adjusted R-squared = .580744	Log likelihood = 4.35101

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	1.26287	.599078	2.10802	[.068]
X2	2.92826	.797958	3.66968	[.006]

log(OBC/IBCTOT), regressed on t  
 =====

Equation 14  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y2  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = -.926150	LM het. test = .753882 [.385]
Std. dev. of dep. var. = .270406	Durbin-Watson = 1.44653 [.080, .297]
Sum of squared residuals = .037731	Jarque-Bera test = .153431 [.926]
Variance of residuals = .471642E-02	Ramsey's RESET2 = 5.21781 [.056]
Std. error of regression = .068676	F (zero slopes) = 131.528 [.000]
R-squared = .942664	Schwarz B.I.C. = -11.4073
Adjusted R-squared = .935497	Log likelihood = 13.7099

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-.102368	.075041	-1.36417	[.210]
T	-.086714	.756100E-02	-11.4686	[.000]

log(OBC/IBCTOT), regressed on intercept  
 =====

Equation 15  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y2  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = -.926150	LM het. test = 0. [1.00]
Std. dev. of dep. var. = .270406	Durbin-Watson = .200698 [.000,.000]
Sum of squared residuals = .658074	Jarque-Bera test = .629600 [.730]
Variance of residuals = .073119	Ramsey's RESET2 = .850706E+38 [.000]
Std. error of regression = .270406	Schwarz B.I.C. = 1.73556
R-squared = .299686E-31	Log likelihood = -.584267
Adjusted R-squared = 0.	

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-.926150	.085510	-10.8309	[.000]

Current sample: 1995 to 2004

	OMS	FDOMS	ULCMS	PCONS	T
1995	700863.00000	563452.12500	0.34785	1.00000	5.00000
1996	710854.00000	608711.00000	0.40879	1.07427	6.00000
1997	705633.00000	607508.75000	0.46641	1.16690	7.00000
1998	735698.00000	599881.87500	0.47185	1.26792	8.00000
1999	728028.00000	601876.12500	0.49374	1.30044	9.00000
2000	757252.00000	622130.43750	0.50352	1.33985	10.00000
2001	812392.00000	643879.12500	0.49849	1.38626	11.00000
2002	793757.00000	663129.06250	0.56413	1.39653	12.00000
2003	794544.00000	693319.93750	0.57960	1.42158	13.00000
2004	852340.00000	719209.81250	0.58427	1.45303	14.00000

OMS on FDOMS: log-linear  
 =====

Equation 16  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = 13.5379	LM het. test = .011113 [.916]
Std. dev. of dep. var. = .067340	Durbin-Watson = 1.74551 [.194, .495]
Sum of squared residuals = .712030E-02	Jarque-Bera test = .124136 [.940]
Variance of residuals = .890038E-03	Ramsey's RESET2 = .962566E-02 [.925]
Std. error of regression = .029833	F (zero slopes) = 37.8541 [.000]
R-squared = .825534	Schwarz B.I.C. = -19.7450
Adjusted R-squared = .803725	Log likelihood = 22.0476

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	2.50997	1.79243	1.40031	[.199]
X1	.825774	.134216	6.15257	[.000]

OMS on FDOMS and t: log-linear  
 =====

Equation 17  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = 13.5379	LM het. test = .730863 [.393]
Std. dev. of dep. var. = .067340	Durbin-Watson = 2.27573 [.327, .930]
Sum of squared residuals = .425360E-02	Jarque-Bera test = .461019 [.794]
Variance of residuals = .607658E-03	Ramsey's RESET2 = .545224 [.488]
Std. error of regression = .024651	F (zero slopes) = 30.0813 [.000]
R-squared = .895775	Schwarz B.I.C. = -21.1696
Adjusted R-squared = .865997	Log likelihood = 24.6235

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	11.1209	4.23213	2.62774	[.034]
X1	.168800	.322162	.523960	[.616]
T	.017124	.788401E-02	2.17201	[.066]

OMS on FDOMS and ULCMS/POMS: log-linear  
 =====

Equation 18  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = 13.5379	LM het. test = 2.33391 [.127]
Std. dev. of dep. var. = .067340	Durbin-Watson = 1.60267 [.042, .590]
Sum of squared residuals = .361579E-02	Jarque-Bera test = .804959 [.669]
Variance of residuals = .516542E-03	Ramsey's RESET2 = 1.78738 [.230]
Std. error of regression = .022728	F (zero slopes) = 36.0049 [.000]
R-squared = .911403	Schwarz B.I.C. = -21.9819
Adjusted R-squared = .886090	Log likelihood = 25.4358

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-.306926	1.74188	-.176204	[.865]
X1	.994889	.121120	8.21409	[.000]
X2	-.576395	.221289	-2.60472	[.035]

OMS on FDOMS, ULCMS/POMS and t: log-linear  
 =====

Equation 19  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = 13.5379	LM het. test = 3.60274 [.058]
Std. dev. of dep. var. = .067340	Durbin-Watson = 2.37617 [.190, .996]
Sum of squared residuals = .230505E-02	Jarque-Bera test = 1.88043 [.391]
Variance of residuals = .384176E-03	Ramsey's RESET2 = .321246 [.595]
Std. error of regression = .019600	F (zero slopes) = 33.4108 [.000]
R-squared = .943520	Schwarz B.I.C. = -23.0816
Adjusted R-squared = .915280	Log likelihood = 27.6868

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	6.44775	3.95341	1.63094	[.154]
X1	.489211	.293017	1.66957	[.146]
X2	-.454691	.201895	-2.25212	[.065]
T	.012250	.663188E-02	1.84711	[.114]

OMS on FDOMS (1.00) and ULCMS/POMS: log-linear  
 =====

Equation 20  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y2  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = .183239	LM het. test = .041557 [.838]
Std. dev. of dep. var. = .030948	Durbin-Watson = 1.60514 [.133, .400]
Sum of squared residuals = .361671E-02	Jarque-Bera test = .856203 [.652]
Variance of residuals = .452089E-03	Ramsey's RESET2 = .355510 [.570]
Std. error of regression = .021262	F (zero slopes) = 11.0672 [.010]
R-squared = .580431	Schwarz B.I.C. = -23.1319
Adjusted R-squared = .527985	Log likelihood = 25.4345

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-.380036	.169451	-2.24275	[.055]
X2	-.581401	.174766	-3.32674	[.010]

OMS on FDOMS (1.00), ULCMS/POMS and t: log-linear  
 =====

Equation 21  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y2  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = .183239	LM het. test = .039462 [.843]
Std. dev. of dep. var. = .030948	Durbin-Watson = 1.67436 [.057, .640]
Sum of squared residuals = .347248E-02	Jarque-Bera test = 2.35014 [.309]
Variance of residuals = .496068E-03	Ramsey's RESET2 = .042988 [.843]
Std. error of regression = .022273	F (zero slopes) = 5.18840 [.041]
R-squared = .597164	Schwarz B.I.C. = -22.1841
Adjusted R-squared = .482068	Log likelihood = 25.6380

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-.436594	.206175	-2.11759	[.072]
X2	-.625574	.200562	-3.11910	[.017]
T	.144860E-02	.268644E-02	.539225	[.606]

ZZZZZZ log(OMS/FDOMS) on ULCMS/POMS and t  
 =====

Equation 22  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y2  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = .183239	LM het. test = .039455 [.843]
Std. dev. of dep. var. = .030948	Durbin-Watson = 1.67437 [.057, .640]
Sum of squared residuals = .347249E-02	Jarque-Bera test = 2.35025 [.309]
Variance of residuals = .496070E-03	Ramsey's RESET2 = .042986 [.843]
Std. error of regression = .022273	F (zero slopes) = 5.18834 [.041]
R-squared = .597161	Schwarz B.I.C. = -22.1841
Adjusted R-squared = .482064	Log likelihood = 25.6380

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-.436592	.206176	-2.11757	[.072]
X2	-.625572	.200563	-3.11908	[.017]
T	.144860E-02	.268645E-02	.539223	[.606]



### E.2.3 CALIBRATION RESULTS FOR REMAINING BEHAVIOURAL EQUATIONS

```

1 ? -----
1 ? -----   HCZ5CALIB_QUICK.TSP   -----
1 ? -----
1
1 ? -----
1 ? --- Quick re-calibration of equations in HC5   ---
1 ? --- The joint factor demand systems are handled ---
1 ? --- seprstely i9n special TSP batch files.   ---
1 ? -----
1
1 OPTIONS LIMERR=10 LIMWARN=1 LIMWNUMC=1;
2
2 IN HCZ5DB;
3
3 ? -----
3 ? OT: GDP arising in manufacturing sector -
3 ? -----
3
3 SMPL 1995 2004;
4 print OT, OW, FDOT, ULCT, POT, PWORLD, t;
5
5 y1=log(OT/OW);
6 x1=log(FDOT);
7 x2=log(PCOMPT);
8 x3=log(RULCT);
9 Title " log(OT/OW) on log(FDOT) & log(PCOMPT): OLSQ";
10  olsq y1 c x1 x2 ;
11 Title " log(OT/OW) on log(FDOT) & log(PCOMPT) & t: OLSQ";
12  olsq y1 c x1 x2 t ;
13 Title "ZZZ log(OT/OW) on log(FDOT) & log(RULCT): OLSQ";
14  olsq y1 c x1 x3 ;
15 Title " log(OT/OW) on log(FDOT) & log(RULCT) & t: OLSQ";
16  olsq y1 c x1 x3 t ;
17
17 y1=log(ot);
18 x1=log(ow);
19 x2=log(ulct/pot);
20 x3=log(fdot);
21 x4=log(pot/pworld);
22
22 Title " OT on OW, RULCT, FDOT, t: unconstrained";
23  ols y1 c x1 x2 x3 t;
24
24 x13=0.5*x1+0.5*x3;
25 y2=y1-x13;
26
26 title " OT on OW(0.5),FDOT(0.5),RULCT & t: log-lin";
27  ols y2 c x2 t;
28
28 ? -----
28 ? WT: Wage rate in manufacturing
28 ? -----
28
28 print WT, POT, LPRT ;
29
29 y1=log(WT/POT);

```

```

30 x1=log(LPRT);
31 Title " WT/POT on LRPT and URBAR: no WEDGE";
32 olsq y1 c x1 urbar;
33
33 y2=y1+0.02*urbar;
34 Title " WT/POT on LRPT and URBAR (-0.02 imposed): no WEDGE";
35 olsq y2 c x1;
36
36 y3=y1-0.8*x1+0.02*urbar;
37 Title "ZZZ WT/POT on LRPT (0.8 imposed) and URBAR (-0.02 imposed)";
38 olsq y3 c ;
39
39 ?-----
39 ? POT: Deflator of GDP in manufacturing -----
39 ?-----
39
39 print POT, PWORLD, ULCT;
40
40 y1=log(pot/ulct);
41 x1=log(pworld/ulct);
42
42 Title " POT on PWORLD and ULCT: homogeneous";
43 ols y1 c x1;
44 ar1 y1 c x1;
45
45 y2=y1-0.70*x1;
46
46 Title "ZZZ POT on PWORLD (0.7) and ULCT: constrained, homogen";
47 ols y2 c ;
48
48
48 ?-----
48 ? OBC: GDP arising in building & construction -----
48 ?-----
48
48 print OBC, IBCTOT, ULCBC, PCONS, t;
49 OBCRAT=OBC/IBCTOT;
50 print OBCRAT;
51
51 y1=log(OBC);
52 x1=log(IBCTOT);
53 x2=log(ULCBC/PCONS);
54
54 title " OBC on IBCTOT: log-linear";
55 ols y1 c x1 ;
56 title " OBC on IBCTOT and t: log-linear";
57 ols y1 c x1 t ;
58 title " OBC on IBCTOT and ULCBC/PCONS: log-linear";
59 ols y1 c x1 x2 ;
60 title " OBC on IBCTOT, ULCBC/PCONS and t: log-linear";
61 ols y1 c x1 x2 t ;
62
62 y2=y1-1.000*x1;
63
63 title "ZZZ OBC on ibctot (1.00) and ULCBC/PCONS: log-linear";
64 ols y2 c x2 ;
65 title " OBC on ibctot (1.00), ULCBC/PCONS and t: log-linear";
66 ols y2 c x2 t ;
67
67
67 ?-----
67 ? POBC: Deflator of GDP arising in building & construction ----

```

```
67 ?-----
67
67 print POBC, ULCBC;
68
68 y1=log(pobc/ulcbc(-1));
69 x1=log(ulcbc/ulcbc(-1));
70
70 title "POBC on ULCBC, ULCBC(-1)";
71 title "ZZZ POBC on ULCBC, ULCBC(-1): log-lin";
72 olsq y1 c x1;
73
73
73
73 ?-----
73 ? OMS: GDP arising in market services -----
73 ?-----
73
73 print OMS, FDOMS, ULCMS, PCONS, t;
74
74 y1=log(OMS);
75 x1=log(FDOMS);
76 x2=log(ULCMS/PCONS);
77
77 title " OMS on FDOMS: log-linear";
78 ols y1 c x1 ;
79 title " OMS on FDOMS and t: log-linear";
80 ols y1 c x1 t ;
81 title "ZZZ OMS on FDOMS and ULCMS/PCONS: log-linear";
82 ols y1 c x1 x2 ;
83 title " OMS on FDOMS, ULCMS/PCONS and t: log-linear";
84 ols y1 c x1 x2 t ;
85
85 y2=y1-1.000*x1;
86
86 title " OMS on FDOMS (1.00) and ULCMS/PCONS: log-linear";
87 ols y2 c x2 ;
88 title " OMS on FDOMS (1.00), ULCMS/PCONS and t: log-linear";
89 ols y2 c x2 t ;
90
90
90 ?-----
90 ? POMS: Deflator of GDP arising in market services -----
90 ?-----
90
90 print POMS, ULCMS;
91
91 y1=log(poms/ulcms(-1));
92 x1=log(ulcms/ulcms(-1));
93
93 title "POMS on ULCMS, ULCMS(-1)";
94 title "ZZZ POMS on ULCMS, ULCMS(-1): log-lin";
95 olsq y1 c x1;
96
96
96 ?-----
96 ? OA: GDP arising in ag., forestry & fishing -----
96 ?-----
96
96 print OA, LA, KA, t;
97
97 y1=log(oa/la);
```

```

98
98 title "ZZZ OA on T";
99 olsq y1 c t;
100
100 ?-----
100 ? LA: numbers employed in ag., forestry & fishing -----
100 ?-----
100
100 y1=log(la);
101
101 title "ZZZ LA on T";
102 olsq y1 c t;
103
103 ?-----
103 ? KA: Fixed capital stock in ag., forestry & fishing -----
103 ?-----
103
103 y1=log(ka/oa);
104
104 title "ZZZ KA/OA on T";
105 olsq y1 c t;
106
106 ?-----
106 ? N: Total population -----
106 ?-----
106
106 print N;
107
107 y1=n-n(-1) ;
108
108 title "ZZZ del(N) on N(-1): no intercept";
109 olsq y1 n(-1);
110
110 ?-----
110 ? NWORK: Working age population (current definition) -----
110 ?-----
110
110 print NWORK;
111
111 y1=NWORK-NWORK(-1);
112
112 title "ZZZ del(NWORK) on NWORK(-1): no intercept";
113 olsq y1 NWORK(-1);
114
114 ?-----
114 ? NELD: Elderly (retired) population -----
114 ?-----
114
114 print NELD;
115
115 y1=NELD-NELD(-1);
116
116 title "ZZZ del(NELD) on NELD(-1): no intercept";
117 olsq y1 neld(-1);
118
118 ?-----
118 ? LFPREQ: Labour force participation rate -----
118 ?-----
118
118 print LFPR, t;
119

```

```
119 title "ZZZ LFPR on T";
120 olsq lfpr c t;
121
121
121 ?-----
121 ? CONSEQ: Private (household) consumption -----
121 ?-----
121
121 print CONS, YRPERD;
122
122 title "ZZZ CONS on YRPERD: linear";
123 olsq cons c yrperd;
124 olsq cons c yrperd yrperd(-1);
125
125
125 ?-----
125 ? DS: Stock changes -----
125 ?-----
125
125 print DS, OT, ST;
126
126 title "ZZZ DS on OT, ST(-1): linear";
127 olsq ds ot st(-1);
128
128
128 ?-----
128 ? PI: Deflators of fixed investment -----
128 ?-----
128
128 print PIT, PGDPFC, PM;
129 y1=log(pit/pm);
130 x1=log(pgdpfc/pm);
131 title "ZZZ PIT on PGDPFC,PM: log-lin";
132 olsq y1 c x1;
133
133 print PIBC, PGDPFC, PM;
134 y1=log(pibc/pm);
135 x1=log(pgdpfc/pm);
136 title "ZZZ PIBC on PGDPFC,PM: log-lin";
137 olsq y1 c x1;
138
138 print PIMS, PGDPFC, PM;
139 y1=log(pims/pm);
140 x1=log(pgdpfc/pm);
141 title "ZZZ PIMS on PGDPFC,PM: log-lin";
142 olsq y1 c x1;
143
143 print PIA, PGDPFC, PM;
144 y1=log(pia/pm);
145 x1=log(pgdpfc/pm);
146 title "ZZZ PIA on PGDPFC,PM: log-lin";
147 olsq y1 c x1;
148
148 print FIG, PGDPFC, PM;
149 y1=log(pig/pm);
150 x1=log(pgdpfc/pm);
151 title "ZZZ FIG on PGDPFC,PM: log-lin";
152 olsq y1 c x1;
153
153 print PIH, PGDPFC, PM;
154 y1=log(pih/pm);
155 x1=log(pgdpfc/pm);
```

```

156 title " PIH on PGDPFC,PM: log-lin";
157 olsq y1 c x1;
158
158 y2=y1-0.90*x1;
159
159 title " PIH on PGDPFC (0.9 imposed),PM: log-lin";
160 ols y2 c ;
161
161
161
161 ?-----
161 ? PCONS: Deflator of private consumption -----
161 ?-----
161
161 print PCONS, PGDPFC, PM;
162 y1=log(pcons/pm);
163 x1=log(pgdpfc/pm);
164
164 title " PCONS on PGDPFC,PM and RGTE(0.0 imposed)";
165 olsq y1 c x1;
166
166 y2=y1-RGTEPD;
167
167 title "ZZZ PCONS on PGDPFC,PM and RGTEPD(1.0 imposed)";
168 olsq y2 c x1;
169
169
169 ?-----
169 ? PDS: Deflator of stock changes -----
169 ?-----
169
169 print PDS, PGDPFC, PM;
170 y1=log(pds/pm);
171 x1=log(pgdpfc/pm);
172
172 title " PDS on PGDPFC,PM)";
173 olsq y1 c x1;
174
174 y2=y1-0.80*x1;
175
175 title "ZZZ PDS on PGDPFC (0.8 imposed),PM: log-lin";
176 ols y2 c ;
177
177
177 ?-----
177 ? YAFS: Adjustment for financial services -----
177 ?-----
177
177 print YAFS, GDPFCV;
178 y1=log(yafs);
179 x1=log(gdpfcv);
180 Title "ZZZ YAFS on GDPFCV and T: log";
181 olsq y1 c x1 t;
182
182
182 ?-----
182 ? DEP: Total depreciation (current prices) -----
182 ?-----
182
182 print DEP, PI, KT, KMS, KBC, KA;
183 y1=log(dep);
184 x1=log(pi*(kt+kbc+kms+ka));
185 Title " DEP on PI*(KT+KBC+KMS+KA)): log";

```

```
186  olsq y1 c x1;
187
187  y2=y1-x1;
188  Title "ZZZ DEP on PI*(KT+KBC+KMS+KA) (1.0 imposed): log";
189  ols y2 c;
190
190
190
190  END
```

Current sample: 1991 to 2004

Current sample: 1995 to 2004

	OT	OW	FDOT	ULCT
1995	317380.00000	1.00000	156496.64063	0.54515
1996	365825.00000	1.00343	169137.62500	0.56370
1997	379038.00000	1.04175	168078.37500	0.62082
1998	344054.00000	1.08167	165938.40625	0.74017
1999	387274.00000	1.10608	165672.39063	0.67852
2000	405738.00000	1.16949	171597.34375	0.65464
2001	392255.00000	1.17083	177986.64063	0.73523
2002	434456.00000	1.16456	183404.96875	0.71343
2003	466839.00000	1.17103	191848.15625	0.66678
2004	497985.00000	1.20495	199495.84375	0.66064

	POT	PWORLD	T
1995	1.00001	1.00000	5.00000
1996	1.08560	0.98328	6.00000
1997	1.15502	1.03045	7.00000
1998	1.29832	1.02751	8.00000
1999	1.28560	1.04876	9.00000
2000	1.27970	1.07123	10.00000
2001	1.35484	1.05365	11.00000
2002	1.31173	0.94697	12.00000
2003	1.28126	0.97403	13.00000
2004	1.31683	0.99475	14.00000

log(OT/OW) on log(FDOT) & log(PCOMPT): OLSQ  
 =====

Equation 1  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = 12.7851	LM het. test = 1.48208 [.223]
Std. dev. of dep. var. = .087399	Durbin-Watson = 2.50686 [.490, .975]
Sum of squared residuals = .013826	Jarque-Bera test = .431343 [.806]
Variance of residuals = .197519E-02	Ramsey's RESET2 = .069101 [.801]
Std. error of regression = .044443	F (zero slopes) = 13.9026 [.004]
R-squared = .798881	Schwarz B.I.C. = -15.2756
Adjusted R-squared = .741419	Log likelihood = 18.7294

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-3.98288	3.79177	-1.05040	[.328]
X1	1.39533	.317117	4.40004	[.003]
X2	-.374383	.235834	-1.58748	[.156]

log(OT/OW) on log(FDOT) & log(PCOMPT) & t: OLSQ



=====  
 Equation 2  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = 12.7851	LM het. test = 2.03754 [.153]
Std. dev. of dep. var. = .087399	Durbin-Watson = 2.72016 [.431,1.00]
Sum of squared residuals = .012866	Jarque-Bera test = .113564 [.945]
Variance of residuals = .214433E-02	Ramsey's RESET2 = .140878E-04 [.997]
Std. error of regression = .046307	F (zero slopes) = 8.68663 [.013]
R-squared = .812850	Schwarz B.I.C. = -14.4842
Adjusted R-squared = .719275	Log likelihood = 19.0894

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-7.73761	6.86208	-1.12759	[.303]
X1	1.71397	.579555	2.95738	[.025]
X2	-.204531	.353270	-.578966	[.584]
T	-.013105	.019583	-.669214	[.528]

ZZZ log(OT/OW) on log(FDOT) & log(RULCT): OLSQ  
 =====

=====  
 Equation 3  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = 12.7851	LM het. test = .060892 [.805]
Std. dev. of dep. var. = .087399	Durbin-Watson = 1.78797 [.088,.714]
Sum of squared residuals = .011673	Jarque-Bera test = .314768 [.854]
Variance of residuals = .166751E-02	Ramsey's RESET2 = .046638 [.836]
Std. error of regression = .040835	F (zero slopes) = 17.1137 [.002]
R-squared = .830210	Schwarz B.I.C. = -16.1222
Adjusted R-squared = .781698	Log likelihood = 19.5761

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	2.95425	2.47654	1.19289	[.272]
X1	.767875	.216208	3.55156	[.009]
X3	-.890751	.430727	-2.06802	[.077]

log(OT/OW) on log(FDOT) & log(RULCT) & t: OLSQ  
 =====

Equation 4  
=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
Current sample: 1995 to 2004  
Number of observations: 10

Mean of dep. var. = 12.7851	LM het. test = .571658 [.450]
Std. dev. of dep. var. = .087399	Durbin-Watson = 2.52633 [.283,1.00]
Sum of squared residuals = .865889E-02	Jarque-Bera test = .547100 [.761]
Variance of residuals = .144315E-02	Ramsey's RESET2 = .175009 [.693]
Std. error of regression = .037989	F (zero slopes) = 13.8790 [.004]
R-squared = .874047	Schwarz B.I.C. = -16.4642
Adjusted R-squared = .811071	Log likelihood = 21.0694

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-4.79226	5.83472	-.821335	[.443]
X1	1.42960	.500143	2.85839	[.029]
X3	-.759175	.410918	-1.84751	[.114]
T	-.016560	.011459	-1.44509	[.199]

OT on OW, RULCT, FDOT, t: unconstrained  
=====

Equation 5  
=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
Current sample: 1995 to 2004  
Number of observations: 10

Mean of dep. var. = 12.8886	LM het. test = 1.39815 [.237]
Std. dev. of dep. var. = .135937	Durbin-Watson = 2.19512 [.010,1.00]
Sum of squared residuals = .476305E-02	Jarque-Bera test = .685491 [.710]
Variance of residuals = .952609E-03	Ramsey's RESET2 = 1.53666 [.283]
Std. error of regression = .030864	F (zero slopes) = 42.3958 [.000]
R-squared = .971360	Schwarz B.I.C. = -18.3014
Adjusted R-squared = .948449	Log likelihood = 24.0579

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	7.93133	7.87770	1.00681	[.360]
X1	-.715295	.848201	-.843308	[.438]
X2	-.982152	.351591	-2.79345	[.038]
X3	.330183	.678735	.486468	[.647]
T	.044792	.031735	1.41147	[.217]

OT on OW(0.5), FDOT(0.5), RULCT & t: log-lin

=====  
 Equation 6  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y2  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = 6.80191	LM het. test = .209358 [.647]
Std. dev. of dep. var. = .075174	Durbin-Watson = 1.80808 [.094, .726]
Sum of squared residuals = .885926E-02	Jarque-Bera test = .318453 [.853]
Variance of residuals = .126561E-02	Ramsey's RESET2 = .092173 [.772]
Std. error of regression = .035575	F (zero slopes) = 16.5929 [.002]
R-squared = .825809	Schwarz B.I.C. = -17.5011
Adjusted R-squared = .776040	Log likelihood = 20.9550

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	6.01758	.208149	28.9100	[.000]
X2	-1.02948	.350941	-2.93348	[.022]
T	.014102	.431571E-02	3.26763	[.014]

	WT	POT	LRPT
1995	136.49532	1.00001	232.31693
1996	162.22191	1.08560	263.53021
1997	177.72978	1.15502	261.17117
1998	195.37135	1.29832	242.36903
1999	214.67569	1.28560	285.35092
2000	229.44630	1.27970	312.12344
2001	240.83099	1.35484	293.13516
2002	251.22876	1.31173	314.35803
2003	268.33264	1.28126	355.62997
2004	288.02457	1.31683	384.78802

WT/POT on LRPT and URBAR: no WEDGE  
 =====

=====  
 Equation 7  
 =====

Method of estimation = Ordinary Least Squares

\*\*\* WARNING in command 32 Procedure OLSQ: Missing values for series  
 =====> URBAR: 1

\*\*\* NOTE: LIMWARN limit reached. Further warning messages will be suppressed.

Dependent variable: Y1  
 Current sample: 1996 to 2004  
 Number of observations: 9

Mean of dep. var. = 5.17015                      LM het. test = .711543 [.399]  
 Std. dev. of dep. var. = .140177                Durbin-Watson = 1.58762 [.030, .625]  
 Sum of squared residuals = .571847E-02        Jarque-Bera test = .562764 [.755]  
 Variance of residuals = .953079E-03        Ramsey's RESET2 = .559139 [.488]  
 Std. error of regression = .030872            F (zero slopes) = 79.4680 [.000]  
    Schwarz B.I.C. = -17.0595  
 Adjusted R-squared = .951496                    Log likelihood = 20.3553

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	.407015	.587818	.692418	[.515]
X1	.824767	.110472	7.46585	[.000]
URBAR	.975931E-02	.882020E-02	1.10647	[.311]

WT/POT on LRPT and URBAR (-0.02 imposed): no WEDGE  
 =====

Equation 8  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y2  
 Current sample: 1996 to 2004  
 Number of observations: 9

Mean of dep. var. = 5.30002                      LM het. test = .788935 [.374]  
 Std. dev. of dep. var. = .171351                Durbin-Watson = .903146 [.005, .070]  
 Sum of squared residuals = .016568            Jarque-Bera test = .298192 [.861]  
 Variance of residuals = .236689E-02        Ramsey's RESET2 = .845179 [.393]  
 Std. error of regression = .048651            F (zero slopes) = 92.2394 [.000]  
    Schwarz B.I.C. = -13.3711  
 Adjusted R-squared = .919387                    Log likelihood = 15.5683

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-.994205	.655567	-1.51656	[.173]
X1	1.10458	.115011	9.60413	[.000]

ZZZ WT/POT on LRPT (0.8 imposed) and URBAR (-0.02 imposed)  
 =====

Equation 9  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y3  
 Current sample: 1996 to 2004  
 Number of observations: 9

Mean of dep. var. = .741379                      LM het. test = .023944 [.877]  
 Std. dev. of dep. var. = .064389                Durbin-Watson = .218925 [.000, .000]  
 Sum of squared residuals = .033168            Jarque-Bera test = .975653 [.614]



VALUE	0.58767	0.10114	0.00000		
F= -19.655713087	FNEW= -19.876129230	ISQZ= 0	STEP= 1.	CRIT= .34761	
F= -19.876129230	FNEW= -20.198415474	ISQZ= 6	STEP= .016	CRIT= 15.074	
F= -20.198415474	FNEW= -20.385458952	ISQZ= 5	STEP= .031	CRIT= 6.8769	
F= -20.385458952	FNEW= -20.446664052	ISQZ= 0	STEP= 1.	CRIT= .12162	
F= -20.446664052	FNEW= -20.447002584	ISQZ= 0	STEP= 1.	CRIT= .68742E-03	
F= -20.447002584	FNEW= -20.447002765	ISQZ= 0	STEP= 1.	CRIT= .36172E-06	
F= -20.447002765	FNEW= -20.447002765	ISQZ= 0	STEP= 1.	CRIT= .12815E-12	

CONVERGENCE ACHIEVED AFTER 7 ITERATIONS

25 FUNCTION EVALUATIONS.

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = .631741	R-squared = .250199
Std. dev. of dep. var. = .037233	Adjusted R-squared = .035970
Sum of squared residuals = .013414	Durbin-Watson = 2.10508
Variance of residuals = .191629E-02	Schwarz B.I.C. = -16.9931
Std. error of regression = .043775	Log likelihood = 20.4470

Parameter	Estimate	Standard Error	t-statistic	P-value
C	.471202	.073331	6.42568	[.000]
X1	.356710	.118792	3.00282	[.003]
RHO	.859980	.205158	4.19180	[.000]

Standard Errors computed from analytic second derivatives (Newton)

ZZZ POT on PWORDL (0.7) and ULCT: constrained, homogen  
 =====

Equation 12  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y2  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = .326750	LM het. test = .598053E-03 [.980]
Std. dev. of dep. var. = .071593	Durbin-Watson = .347979 [.000,.000]
Sum of squared residuals = .046130	Jarque-Bera test = .852074 [.653]
Variance of residuals = .512553E-02	Ramsey's RESET2 = .850706E+38 [.000]
Std. error of regression = .071593	Schwarz B.I.C. = -11.5537
R-squared = 0.	Log likelihood = 12.7050
Adjusted R-squared = 0.	

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value	
C	.326750	.022640	14.4326	[.000]	
	OBC	IBCTOT	ULCBC	PCONS	T
1995	125447.00000	191113.98438	0.50642	1.00000	5.00000

1996	110363.00000	210874.70313	0.57208	1.07427	6.00000
1997	97136.00000	215721.10938	0.68821	1.16690	7.00000
1998	100473.00000	219678.59375	0.69468	1.26792	8.00000
1999	78404.00000	189853.25000	0.81364	1.30044	9.00000
2000	78141.00000	206062.51563	0.82002	1.33985	10.00000
2001	71761.00000	227451.06250	0.91027	1.38626	11.00000
2002	74013.00000	237701.06250	0.86388	1.39653	12.00000
2003	77751.00000	253139.75000	0.90935	1.42158	13.00000
2004	77392.00000	272304.90625	0.98010	1.45303	14.00000

OBCRAT	
1995	0.65640
1996	0.52336
1997	0.45029
1998	0.45736
1999	0.41297
2000	0.37921
2001	0.31550
2002	0.31137
2003	0.30715
2004	0.28421

OBC on IBCTOT: log-linear

=====

Equation 13

=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = 11.3800	LM het. test = 7.51389 [.006]
Std. dev. of dep. var. = .192902	Durbin-Watson = .710600 [.001,.020]
Sum of squared residuals = .248988	Jarque-Bera test = .793181 [.673]
Variance of residuals = .031124	Ramsey's RESET2 = .704409E-02 [.935]
Std. error of regression = .176419	F (zero slopes) = 2.76034 [.135]
R-squared = .256529	Schwarz B.I.C. = -1.97270
Adjusted R-squared = .163595	Log likelihood = 4.27528

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	21.7901	6.26601	3.47750	[.008]
X1	-.845929	.509159	-1.66143	[.135]

OBC on IBCTOT and t: log-linear

=====

Equation 14

=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = 11.3800	LM het. test = 1.49656 [.221]
Std. dev. of dep. var. = .192902	Durbin-Watson = 1.46348 [.021, .488]
Sum of squared residuals = .037701	Jarque-Bera test = .141779 [.932]
Variance of residuals = .538593E-02	Ramsey's RESET2 = 2.00367 [.207]
Std. error of regression = .073389	F (zero slopes) = 27.5903 [.000]
R-squared = .887425	Schwarz B.I.C. = -10.2599
Adjusted R-squared = .855260	Log likelihood = 13.7138

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-.429421	4.40221	-.097546	[.925]
X1	1.02723	.366474	2.80301	[.026]
T	-.087562	.013980	-6.26334	[.000]

OBC on IBCTOT and ULCBC/PCONS: log-linear

Equation 15

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = 11.3800	LM het. test = .299773 [.584]
Std. dev. of dep. var. = .192902	Durbin-Watson = 1.96862 [.156, .815]
Sum of squared residuals = .032890	Jarque-Bera test = .241847 [.886]
Variance of residuals = .469852E-02	Ramsey's RESET2 = 1.38882 [.283]
Std. error of regression = .068546	F (zero slopes) = 32.1389 [.000]
R-squared = .901793	Schwarz B.I.C. = -10.9426
Adjusted R-squared = .873733	Log likelihood = 14.3965

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	7.49974	3.21984	2.32923	[.053]
X1	.227604	.253365	.898326	[.399]
X2	-2.09913	.309524	-6.78181	[.000]

OBC on IBCTOT, ULCBC/PCONS and t: log-linear

Equation 16

Method of estimation = Ordinary Least Squares



Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = 11.3800	LM het. test = .088715 [.766]
Std. dev. of dep. var. = .192902	Durbin-Watson = 1.44958 [.000,.700]
Sum of squared residuals = .018917	Jarque-Bera test = .544795 [.762]
Variance of residuals = .315283E-02	Ramsey's RESET2 = 3.14619 [.136]
Std. error of regression = .056150	F (zero slopes) = 33.4073 [.000]
R-squared = .943514	Schwarz B.I.C. = -12.5568
Adjusted R-squared = .915272	Log likelihood = 17.1620

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	2.44218	3.56770	.684525	[.519]
X1	.709770	.309086	2.29635	[.061]
X2	-1.20620	.494165	-2.44089	[.050]
T	-.043886	.020847	-2.10518	[.080]

ZZZ OBC on ibctot (1.00) and ULCBC/PCONS: log-linear  
 =====

Equation 17  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y2  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = -.926151	LM het. test = .024941 [.875]
Std. dev. of dep. var. = .270406	Durbin-Watson = 2.39209 [.598,.865]
Sum of squared residuals = .076556	Jarque-Bera test = .184337 [.912]
Variance of residuals = .956951E-02	Ramsey's RESET2 = .032230 [.863]
Std. error of regression = .097824	F (zero slopes) = 60.7677 [.000]
R-squared = .883666	Schwarz B.I.C. = -7.86961
Adjusted R-squared = .869125	Log likelihood = 10.1722

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-2.30856	.180015	-12.8242	[.000]
X2	-2.68867	.344906	-7.79536	[.000]

OBC on ibctot (1.00), ULCBC/PCONS and t: log-linear  
 =====

Equation 18  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y2  
 Current sample: 1995 to 2004

Number of observations: 10

Mean of dep. var. = -.926151                      LM het. test = .399441 [.527]  
 Std. dev. of dep. var. = .270406                      Durbin-Watson = 1.61529 [.045, .599]  
 Sum of squared residuals = .021697                      Jarque-Bera test = 1.02760 [.598]  
 Variance of residuals = .309956E-02                      Ramsey's RESET2 = 2.69291 [.152]  
 Std. error of regression = .055674                      F (zero slopes) = 102.656 [.000]  
    Schwarz B.I.C. = -13.0226  
 Adjusted R-squared = .957610                      Log likelihood = 16.4765

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-.891227	.352130	-2.53096	[.039]
X2	-1.01095	.444482	-2.27445	[.057]
T	-.058391	.013879	-4.20702	[.004]

	POBC	ULCBC
1995	1.00000	0.50642
1996	1.11687	0.57208
1997	1.31181	0.68821
1998	1.49764	0.69468
1999	1.65910	0.81364
2000	1.71759	0.82002
2001	1.91657	0.91027
2002	2.00000	0.86388
2003	2.12658	0.90935
2004	2.24192	0.98010

POBC on ULCBC, ULCBC(-1)

=====

ZZZ POBC on ULCBC, ULCBC(-1): log-lin

=====

Equation 19

=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1

Current sample: 1996 to 2004

Number of observations: 9

Mean of dep. var. = .828379                      LM het. test = .112905 [.737]  
 Std. dev. of dep. var. = .056141                      Durbin-Watson = .990150 [.010, .097]  
 Sum of squared residuals = .020588                      Jarque-Bera test = .740617 [.691]  
 Variance of residuals = .294115E-02                      Ramsey's RESET2 = .869037 [.387]  
 Std. error of regression = .054232                      F (zero slopes) = 1.57300 [.250]  
    Schwarz B.I.C. = -12.3935  
 Adjusted R-squared = .066838                      Log likelihood = 14.5908

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	.805506	.025679	31.3687	[.000]
X1	.311770	.248582	1.25419	[.250]

	OMS	FDOMS	ULCMS	PCONS	T
1995	700863.00000	563452.12500	0.34785	1.00000	5.00000
1996	710854.00000	608711.00000	0.40879	1.07427	6.00000
1997	705633.00000	607508.75000	0.46641	1.16690	7.00000
1998	735698.00000	599881.87500	0.47185	1.26792	8.00000
1999	728028.00000	601876.12500	0.49374	1.30044	9.00000
2000	757252.00000	622130.43750	0.50352	1.33985	10.00000
2001	812392.00000	643879.12500	0.49849	1.38626	11.00000
2002	793757.00000	663129.06250	0.56413	1.39653	12.00000
2003	794544.00000	693319.93750	0.57960	1.42158	13.00000
2004	852340.00000	719209.81250	0.58427	1.45303	14.00000

OMS on FDOMS: log-linear

=====

Equation 20

=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1

Current sample: 1995 to 2004

Number of observations: 10

Mean of dep. var. = 13.5379	LM het. test = .011113 [.916]
Std. dev. of dep. var. = .067340	Durbin-Watson = 1.74551 [.194, .495]
Sum of squared residuals = .712030E-02	Jarque-Bera test = .124136 [.940]
Variance of residuals = .890038E-03	Ramsey's RESET2 = .962566E-02 [.925]
Std. error of regression = .029833	F (zero slopes) = 37.8541 [.000]
R-squared = .825534	Schwarz B.I.C. = -19.7450
Adjusted R-squared = .803725	Log likelihood = 22.0476

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	2.50997	1.79243	1.40031	[.199]
X1	.825774	.134216	6.15257	[.000]

OMS on FDOMS and t: log-linear

=====

Equation 21

=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1

Current sample: 1995 to 2004

Number of observations: 10

Mean of dep. var. = 13.5379	LM het. test = .730863 [.393]
Std. dev. of dep. var. = .067340	Durbin-Watson = 2.27573 [.327, .930]
Sum of squared residuals = .425360E-02	Jarque-Bera test = .461019 [.794]
Variance of residuals = .607658E-03	Ramsey's RESET2 = .545224 [.488]

Std. error of regression = .024651      F (zero slopes) = 30.0813 [.000]  
    R-squared = .895775      Schwarz B.I.C. = -21.1696  
    Adjusted R-squared = .865997      Log likelihood = 24.6235

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	11.1209	4.23213	2.62774	[.034]
X1	.168800	.322162	.523960	[.616]
T	.017124	.788401E-02	2.17201	[.066]

ZZZ OMS on FDOMS and ULCMS/PCONS: log-linear  
 =====

Equation 22  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = 13.5379	LM het. test = .010639 [.918]
Std. dev. of dep. var. = .067340	Durbin-Watson = 1.87985 [.119, .768]
Sum of squared residuals = .201065E-02	Jarque-Bera test = .349592 [.840]
Variance of residuals = .287236E-03	Ramsey's RESET2 = .360377 [.570]
Std. error of regression = .016948	F (zero slopes) = 67.5424 [.000]
R-squared = .950734	Schwarz B.I.C. = -24.9161
Adjusted R-squared = .936658	Log likelihood = 28.3700

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-2.46474	1.55821	-1.58177	[.158]
X1	1.15233	.108666	10.6044	[.000]
X2	-.638402	.151362	-4.21770	[.004]

OMS on FDOMS, ULCMS/PCONS and t: log-linear  
 =====

Equation 23  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = 13.5379	LM het. test = 1.99548 [.158]
Std. dev. of dep. var. = .067340	Durbin-Watson = 2.73941 [.446, 1.00]
Sum of squared residuals = .889642E-03	Jarque-Bera test = .624524 [.732]
Variance of residuals = .148274E-03	Ramsey's RESET2 = .110981 [.753]
Std. error of regression = .012177	F (zero slopes) = 89.7490 [.000]
R-squared = .978201	Schwarz B.I.C. = -27.8418
Adjusted R-squared = .967302	Log likelihood = 32.4470

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	3.92461	2.57935	1.52155	[.179]
X1	.672735	.191099	3.52035	[.013]
X2	-.543471	.114099	-4.76314	[.003]
T	.011235	.408603E-02	2.74962	[.033]

OMS on FDOMS (1.00) and ULCMS/PCONS: log-linear  
=====

Equation 24  
=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y2  
Current sample: 1995 to 2004  
Number of observations: 10

Mean of dep. var. = .183239	LM het. test = .154090 [.695]
Std. dev. of dep. var. = .030948	Durbin-Watson = 1.39209 [.066, .264]
Sum of squared residuals = .257511E-02	Jarque-Bera test = .499150 [.779]
Variance of residuals = .321889E-03	Ramsey's RESET2 = .599113E-02 [.940]
Std. error of regression = .017941	F (zero slopes) = 18.7797 [.002]
R-squared = .701266	Schwarz B.I.C. = -24.8303
Adjusted R-squared = .663924	Log likelihood = 27.1329

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-.285091	.108220	-2.63437	[.030]
X2	-.487218	.112429	-4.33355	[.002]

OMS on FDOMS (1.00), ULCMS/PCONS and t: log-linear  
=====

Equation 25  
=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y2  
Current sample: 1995 to 2004  
Number of observations: 10

Mean of dep. var. = .183239	LM het. test = 2.84576 [.092]
Std. dev. of dep. var. = .030948	Durbin-Watson = 2.37933 [.398, .954]
Sum of squared residuals = .132450E-02	Jarque-Bera test = .178662 [.915]
Variance of residuals = .189214E-03	Ramsey's RESET2 = .017010 [.900]
Std. error of regression = .013756	F (zero slopes) = 19.2786 [.001]
R-squared = .846347	Schwarz B.I.C. = -27.0033
Adjusted R-squared = .802446	Log likelihood = 30.4571

Estimated Standard

Variable	Coefficient	Error	t-statistic	P-value
C	-.489206	.114838	-4.25996	[.004]
X2	-.651651	.107336	-6.07111	[.001]
T	.484817E-02	.188579E-02	2.57089	[.037]

	POMS	ULCMS
1995	1.0000	0.34785
1996	1.06161	0.40879
1997	1.16584	0.46641
1998	1.27018	0.47185
1999	1.30471	0.49374
2000	1.31307	0.50352
2001	1.36667	0.49849
2002	1.44412	0.56413
2003	1.50923	0.57960
2004	1.48936	0.58427

POMS on ULCMS, ULCMS(-1)

=====

ZZZ POMS on ULCMS, ULCMS(-1): log-lin

=====

Equation 26

=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1996 to 2004  
 Number of observations: 9

Mean of dep. var. = 1.01676	LM het. test = .633305 [ .426]
Std. dev. of dep. var. = .051751	Durbin-Watson = 1.97584 [ .308, .663]
Sum of squared residuals = .405469E-02	Jarque-Bera test = .481874 [ .786]
Variance of residuals = .579241E-03	Ramsey's RESET2 = 1.58427 [ .255]
Std. error of regression = .024067	F (zero slopes) = 29.9887 [ .001]
R-squared = .810753	Schwarz B.I.C. = -19.7053
Adjusted R-squared = .783718	Log likelihood = 21.9025

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	.974531	.011128	87.5754	[.000]
X1	.732898	.133833	5.47620	[.001]
	OA	LA	KA	T
1995	63567.00000	309.04099	298732.43750	5.00000
1996	63144.00000	329.80600	311550.43750	6.00000
1997	61135.00000	279.84000	315479.43750	7.00000
1998	68319.00000	269.72601	319303.43750	8.00000
1999	71113.00000	234.71300	319177.43750	9.00000
2000	75166.00000	226.96400	319985.43750	10.00000
2001	69917.00000	207.91800	322467.43750	11.00000
2002	71904.00000	189.34900	326499.43750	12.00000
2003	75367.00000	204.53900	330484.43750	13.00000
2004	76963.00000	202.53900	331449.43750	14.00000

ZZZ OA on T  
=====

Equation 27  
=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
Current sample: 1995 to 2004  
Number of observations: 10

Mean of dep. var. = 5.66255	LM het. test = .931635E-04 [.992]
Std. dev. of dep. var. = .265197	Durbin-Watson = 1.12007 [.020,.127]
Sum of squared residuals = .055009	Jarque-Bera test = .857264 [.651]
Variance of residuals = .687609E-02	Ramsey's RESET2 = 3.27669 [.113]
Std. error of regression = .082922	F (zero slopes) = 84.0531 [.000]
R-squared = .913094	Schwarz B.I.C. = -9.52227
Adjusted R-squared = .902230	Log likelihood = 11.8249

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	4.86740	.090607	53.7200	[.000]
T	.083699	.912943E-02	9.16805	[.000]

ZZZ LA on T  
=====

Equation 28  
=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
Current sample: 1995 to 2004  
Number of observations: 10

Mean of dep. var. = 5.48592	LM het. test = .936009 [.333]
Std. dev. of dep. var. = .193410	Durbin-Watson = 1.47552 [.089,.315]
Sum of squared residuals = .038790	Jarque-Bera test = .657664 [.720]
Variance of residuals = .484878E-02	Ramsey's RESET2 = 3.37722 [.109]
Std. error of regression = .069633	F (zero slopes) = 61.4332 [.000]
R-squared = .884781	Schwarz B.I.C. = -11.2689
Adjusted R-squared = .870379	Log likelihood = 13.5715

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	6.05676	.076086	79.6037	[.000]
T	-.060088	.766636E-02	-7.83793	[.000]

ZZZ KA/OA on T

=====

Equation 29

=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
Current sample: 1995 to 2004  
Number of observations: 10

Mean of dep. var. = 1.52567	LM het. test = 1.19244 [.275]
Std. dev. of dep. var. = .059863	Durbin-Watson = 1.67697 [.163, .449]
Sum of squared residuals = .015608	Jarque-Bera test = .048816 [.976]
Variance of residuals = .195098E-02	Ramsey's RESET2 = .267092E-02 [.960]
Std. error of regression = .044170	F (zero slopes) = 8.53135 [.019]
R-squared = .516071	Schwarz B.I.C. = -15.8209
Adjusted R-squared = .455580	Log likelihood = 18.1234

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	1.66061	.048263	34.4073	[.000]
T	-.014204	.486295E-02	-2.92085	[.019]

	N
1995	10330.75879
1996	10315.35254
1997	10303.64160
1998	10294.94336
1999	10282.78418
2000	10272.50293
2001	10224.19238
2002	10200.77441
2003	10201.65137
2004	10206.92285

ZZZ del(N) on N(-1): no intercept

=====

Equation 30

=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
Current sample: 1996 to 2004  
Number of observations: 9

Mean of dep. var. = -13.7595	LM het. test = .576696 [.448]
Std. dev. of dep. var. = 15.4542	Durbin-Watson = 1.42162 [.176, .176]
Sum of squared residuals = 1906.10	Jarque-Bera test = 2.36986 [.306]
Variance of residuals = 238.262	Ramsey's RESET2 = .579249 [.471]
Std. error of regression = 15.4357	Schwarz B.I.C. = 37.9692
R-squared = .079620	Log likelihood = -36.8706
Adjusted R-squared = .079620	



Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
N(-1)	-.134160E-02	.501011E-03	-2.67779	[.028]

	NWORK
1995	7043.75879
1996	7066.35254
1997	7088.64160
1998	7113.94336
1999	7137.78418
2000	7165.50293
2001	7168.19238
2002	7179.77441
2003	7210.65137
2004	7239.92285

ZZZ del(NWORK) on NWORK(-1): no intercept  
=====

Equation 31  
=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
Current sample: 1996 to 2004  
Number of observations: 9

Mean of dep. var. = 21.7960	LM het. test = 1.96279 [.161]
Std. dev. of dep. var. = 9.08407	Durbin-Watson = 1.67567 [.304, .304]
Sum of squared residuals = 661.898	Jarque-Bera test = 2.20164 [.333]
Variance of residuals = 82.7372	Ramsey's RESET2 = .042191 [.843]
Std. error of regression = 9.09600	Schwarz B.I.C. = 33.2095
R-squared = .361844E-02	Log likelihood = -32.1109
Adjusted R-squared = .361844E-02	

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
NWORK(-1)	.305602E-02	.425203E-03	7.18720	[.000]

	NELD
1995	1366.00000
1996	1382.00000
1997	1397.00000
1998	1408.00000
1999	1416.00000
2000	1422.00000
2001	1413.00000
2002	1416.00000
2003	1420.00000
2004	1428.00000

ZZZ del(NELD) on NELD(-1): no intercept  
=====

Equation 32  
=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
Current sample: 1996 to 2004  
Number of observations: 9

Mean of dep. var. = 6.88889      LM het. test = .592439E-02 [.939]  
Std. dev. of dep. var. = 7.45729      Durbin-Watson = .923415 [.032,.032]  
Sum of squared residuals = 453.718      Jarque-Bera test = 1.13794 [.566]  
Variance of residuals = 56.7147      Ramsey's RESET2 = 11.8083 [.011]  
Std. error of regression = 7.53092      Schwarz B.I.C. = 31.5102  
R-squared = .615873      Log likelihood = -30.4116  
Adjusted R-squared = .615873

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
NELD(-1)	.485370E-02	.178725E-02	2.71573	[.026]

	LFPR	T
1995	76.40539	5.00000
1996	75.80861	6.00000
1997	76.39246	7.00000
1998	74.16196	8.00000
1999	74.19120	9.00000
2000	73.58310	10.00000
2001	73.31876	11.00000
2002	73.61914	12.00000
2003	72.72820	13.00000
2004	72.85403	14.00000

ZZZ LFPR on T  
=====

Equation 33  
=====

Method of estimation = Ordinary Least Squares

Dependent variable: LFPR  
Current sample: 1995 to 2004  
Number of observations: 10

Mean of dep. var. = 74.3063      LM het. test = .495527 [.481]  
Std. dev. of dep. var. = 1.39917      Durbin-Watson = 2.20838 [.473,.783]  
Sum of squared residuals = 2.54527      Jarque-Bera test = .383575 [.825]  
Variance of residuals = .318158      Ramsey's RESET2 = 2.27579 [.175]  
Std. error of regression = .564055      F (zero slopes) = 47.3788 [.000]  
R-squared = .855540      Schwarz B.I.C. = 9.65022  
Adjusted R-squared = .837483      Log likelihood = -7.34763

Estimated	Standard
-----------	----------

Variable	Coefficient	Error	t-statistic	P-value
C	78.3671	.616329	127.151	[.000]
T	-.427451	.062100	-6.88322	[.000]

	CONS	YRPERD
1995	734611.00000	1155598.00000
1996	799591.00000	1180469.12500
1997	810366.00000	1224684.75000
1998	798053.00000	1206881.37500
1999	814795.00000	1207287.12500
2000	838035.00000	1192087.62500
2001	860098.00000	1238637.00000
2002	884155.00000	1313628.62500
2003	925077.00000	1347152.50000
2004	956021.00000	1393977.62500

ZZZ CONS on YRPERD: linear  
 =====

Equation 34  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: CONS  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = 842080.	LM het. test = 2.74012 [.098]
Std. dev. of dep. var. = 65849.9	Durbin-Watson = 1.47357 [.088, .314]
Sum of squared residuals = .399045E+10	Jarque-Bera test = .145644 [.930]
Variance of residuals = .498806E+09	Ramsey's RESET2 = .638031 [.451]
Std. error of regression = 22334.0	F (zero slopes) = 70.2387 [.000]
R-squared = .897749	Schwarz B.I.C. = 115.515
Adjusted R-squared = .884967	Log likelihood = -113.212

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-146917.	118218.	-1.24277	[.249]
YRPERD	.793712	.094705	8.38085	[.000]

Equation 35  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: CONS  
 Current sample: 1996 to 2004  
 Number of observations: 9

Mean of dep. var. = 854021.	LM het. test = 2.31658 [.128]
Std. dev. of dep. var. = 57219.9	Durbin-Watson = 1.26606 [.004, .394]
Sum of squared residuals = .221475E+10	Jarque-Bera test = .301689 [.860]
Variance of residuals = .369124E+09	Ramsey's RESET2 = .125165 [.738]
Std. error of regression = 19212.6	F (zero slopes) = 32.4799 [.001]

R-squared = .915445                      Schwarz B.I.C. = 103.012  
 Adjusted R-squared = .887260            Log likelihood = -99.7158

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-83168.8	136199.	-.610641	[.564]
YRPERD	.619339	.222031	2.78942	[.032]
YRPERD(-1)	.129509	.270713	.478401	[.649]

	DS	OT	ST
1995	13210.00000	317380.00000	79345.00000
1996	26208.00000	365825.00000	105553.00000
1997	11108.00000	379038.00000	116661.00000
1998	4589.00000	344054.00000	121250.00000
1999	1045.00000	387274.00000	122295.00000
2000	20854.00000	405738.00000	143149.00000
2001	26720.00000	392255.00000	169869.00000
2002	27857.00000	434456.00000	197726.00000
2003	10088.00000	466839.00000	207814.00000
2004	25308.00000	497985.00000	233122.00000

ZZZ DS on OT, ST(-1): linear  
 =====

Equation 36  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: DS  
 Current sample: 1996 to 2004  
 Number of observations: 9

Mean of dep. var. = 17086.3	LM het. test = 1.27360 [.259]
Std. dev. of dep. var. = 10440.5	Durbin-Watson = 1.56199 [.115, .396]
Sum of squared residuals = .786976E+09	Jarque-Bera test = .926065 [.629]
Variance of residuals = .112425E+09	Ramsey's RESET2 = .638387 [.455]
Std. error of regression = 10603.1	F (zero slopes) = .756586 [.413]
R-squared = .160279	Schwarz B.I.C. = 97.2568
Adjusted R-squared = .040319	Log likelihood = -95.0596

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
OT	.051371	.047284	1.08643	[.313]
ST(-1)	-.026142	.132882	-.196728	[.850]

	PIT	PGDPFC	PM
1995	1.00000	1.00000	1.00000
1996	1.03425	1.07677	1.01794
1997	1.07790	1.17791	1.07058
1998	1.11095	1.29266	1.05091
1999	1.13697	1.31223	1.06770
2000	1.16399	1.31667	1.13417
2001	1.17386	1.39029	1.10519
2002	1.11726	1.43183	1.01191
2003	1.14253	1.48295	1.00665
2004	1.15548	1.50088	1.02281

ZZZ PIT on PGDPFC,PM: log-lin  
 =====

Equation 37  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = .057498	LM het. test = 2.48054 [.115]
Std. dev. of dep. var. = .046309	Durbin-Watson = 1.72732 [.186, .483]
Sum of squared residuals = .737120E-03	Jarque-Bera test = .865066 [.649]
Variance of residuals = .921400E-04	Ramsey's RESET2 = 4.52669 [.071]
Std. error of regression = .959896E-02	F (zero slopes) = 201.476 [.000]
R-squared = .961809	Schwarz B.I.C. = -31.0848
Adjusted R-squared = .957036	Log likelihood = 33.3873

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-.011617	.573791E-02	-2.02469	[.077]
X1	.335233	.023618	14.1942	[.000]

	PIBC	PGDPFC	PM
1995	1.00000	1.00000	1.00000
1996	1.03945	1.07677	1.01794
1997	1.09767	1.17791	1.07058
1998	1.15318	1.29266	1.05091
1999	1.18640	1.31223	1.06770
2000	1.22555	1.31667	1.13417
2001	1.23534	1.39029	1.10519
2002	1.19988	1.43183	1.01191
2003	1.47749	1.48295	1.00665
2004	1.54876	1.50088	1.02281

ZZZ PIBC on PGDPFC,PM: log-lin  
 =====

Equation 38  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = .140199	LM het. test = 6.78159 [.009]
Std. dev. of dep. var. = .145699	Durbin-Watson = 1.11461 [.019, .125]
Sum of squared residuals = .037042	Jarque-Bera test = .343655 [.842]

Variance of residuals = .463024E-02      Ramsey's RESET2 = 6.70998 [.036]  
 Std. error of regression = .068046      F (zero slopes) = 33.2621 [.000]  
    R-squared = .806118      Schwarz B.I.C. = -11.4995  
    Adjusted R-squared = .781882      Log likelihood = 13.8021

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-.058875	.040675	-1.44743	[.186]
X1	.965579	.167422	5.76733	[.000]

	PIMS	PGDPFC	PM
1995	1.00000	1.00000	1.00000
1996	1.04726	1.07677	1.01794
1997	1.11922	1.17791	1.07058
1998	1.18178	1.29266	1.05091
1999	1.21461	1.31223	1.06770
2000	1.26022	1.31667	1.13417
2001	1.28655	1.39029	1.10519
2002	1.26686	1.43183	1.01191
2003	1.27093	1.48295	1.00665
2004	1.33393	1.50088	1.02281

ZZZ PIMS on PGDPFC,PM: log-lin  
 =====

Equation 39  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = .129984      LM het. test = 3.09775 [.078]  
 Std. dev. of dep. var. = .090541      Durbin-Watson = 1.79420 [.219, .529]  
 Sum of squared residuals = .120598E-02      Jarque-Bera test = .506707 [.776]  
 Variance of residuals = .150748E-03      Ramsey's RESET2 = .074061 [.793]  
 Std. error of regression = .012278      F (zero slopes) = 481.416 [.000]  
    R-squared = .983654      Schwarz B.I.C. = -28.6233  
    Adjusted R-squared = .981611      Log likelihood = 30.9258

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-.667038E-02	.733930E-02	-.908858	[.390]
X1	.662822	.030209	21.9412	[.000]

	PIA	PGDPFC	PM
1995	1.00000	1.00000	1.00000
1996	1.04103	1.07677	1.01794
1997	1.09540	1.17791	1.07058
1998	1.13543	1.29266	1.05091
1999	1.14615	1.31223	1.06770
2000	1.19012	1.31667	1.13417
2001	1.21369	1.39029	1.10519
2002	1.15795	1.43183	1.01191
2003	1.15453	1.48295	1.00665
2004	1.19705	1.50088	1.02281

ZZZ PIA on PGDPFC,PM: log-lin  
 =====

Equation 40  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = .076460	LM het. test = 2.52321 [.112]
Std. dev. of dep. var. = .054134	Durbin-Watson = 2.39648 [.601,.867]
Sum of squared residuals = .521669E-03	Jarque-Bera test = .806749 [.668]
Variance of residuals = .652086E-04	Ramsey's RESET2 = .325111 [.586]
Std. error of regression = .807518E-02	F (zero slopes) = 396.465 [.000]
R-squared = .980221	Schwarz B.I.C. = -32.8133
Adjusted R-squared = .977748	Log likelihood = 35.1159

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-.510274E-02	.482705E-02	-1.05711	[.321]
X1	.395608	.019868	19.9114	[.000]

	PIG	PGDPFC	PM
1995	1.00000	1.00000	1.00000
1996	1.05383	1.07677	1.01794
1997	1.14447	1.17791	1.07058
1998	1.21046	1.29266	1.05091
1999	1.24243	1.31223	1.06770
2000	1.28467	1.31667	1.13417
2001	1.31820	1.39029	1.10519
2002	1.28987	1.43183	1.01191
2003	1.29866	1.48295	1.00665
2004	1.35441	1.50088	1.02281

ZZZ PIG on PGDPFC,PM: log-lin  
 =====

Equation 41  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = .147337	LM het. test = 1.29955 [.254]
Std. dev. of dep. var. = .094722	Durbin-Watson = 1.55977 [.117,.370]

Sum of squared residuals = .106519E-02 Jarque-Bera test = .311943 [.856]  
 Variance of residuals = .133148E-03 Ramsey's RESET2 = 1.75297 [.227]  
 Std. error of regression = .011539 F (zero slopes) = 598.465 [.000]  
 R-squared = .986809 Schwarz B.I.C. = -29.2440  
 Adjusted R-squared = .985160 Log likelihood = 31.5466

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	.414277E-02	.689759E-02	.600611	[.565]
X1	.694542	.028391	24.4635	[.000]

	PIH	PGDPFC	PM
1995	1.00000	1.00000	1.00000
1996	1.06832	1.07677	1.01794
1997	1.17955	1.17791	1.07058
1998	1.28983	1.29266	1.05091
1999	1.34935	1.31223	1.06770
2000	1.40506	1.31667	1.13417
2001	1.46210	1.39029	1.10519
2002	1.47088	1.43183	1.01191
2003	1.60882	1.48295	1.00665
2004	1.68501	1.50088	1.02281

PIH on PGDPFC,PM: log-lin  
 =====

Equation 42  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = .242036 LM het. test = 1.01581 [.314]  
 Std. dev. of dep. var. = .168603 Durbin-Watson = 1.66782 [.159, .442]  
 Sum of squared residuals = .694615E-02 Jarque-Bera test = .276703 [.871]  
 Variance of residuals = .868269E-03 Ramsey's RESET2 = .347748 [.574]  
 Std. error of regression = .029466 F (zero slopes) = 286.657 [.000]  
 R-squared = .972850 Schwarz B.I.C. = -19.8688  
 Adjusted R-squared = .969456 Log likelihood = 22.1714

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-.011037	.017614	-.626612	[.548]
X1	1.22749	.072500	16.9309	[.000]

PIH on PGDPFC (0.9 imposed),PM: log-lin  
 =====

Equation 43  
 =====

Method of estimation = Ordinary Least Squares



Dependent variable: Y2  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = .056482                    LM het. test = 0. [1.00]  
 Std. dev. of dep. var. = .052348            Durbin-Watson = .279027 [.000,.000]  
 Sum of squared residuals = .024663        Jarque-Bera test = .746499 [.688]  
 Variance of residuals = .274032E-02      Ramsey's RESET2 = .850706E+38 [.000]  
 Std. error of regression = .052348        Schwarz B.I.C. = -14.6845  
    R-squared = .175703E-32      Log likelihood = 15.8358  
 Adjusted R-squared = 0.

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	.056482	.016554	3.41203	[.008]

	PCONS	PGDPFC	PM
1995	1.00000	1.00000	1.00000
1996	1.07427	1.07677	1.01794
1997	1.16690	1.17791	1.07058
1998	1.26792	1.29266	1.05091
1999	1.30044	1.31223	1.06770
2000	1.33985	1.31667	1.13417
2001	1.38626	1.39029	1.10519
2002	1.39653	1.43183	1.01191
2003	1.42158	1.48295	1.00665
2004	1.45303	1.50088	1.02281

PCONS on PGDPFC,PM and RGTE(0.0 imposed)  
 =====

Equation 44  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = .193657                    LM het. test = .425959 [.514]  
 Std. dev. of dep. var. = .122344            Durbin-Watson = .994652 [.010,.081]  
 Sum of squared residuals = .108378E-02      Jarque-Bera test = 2.25687 [.324]  
 Variance of residuals = .135472E-03      Ramsey's RESET2 = 3.37048 [.109]  
 Std. error of regression = .011639        F (zero slopes) = 986.395 [.000]  
    R-squared = .991955            Schwarz B.I.C. = -29.1575  
 Adjusted R-squared = .990949            Log likelihood = 31.4601

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	.822392E-02	.695752E-02	1.18202	[.271]
X1	.899417	.028638	31.4069	[.000]

ZZZ PCONS on PGDPFC,PM and RGTEPD(1.0 imposed)

=====  
Equation 45  
=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y2  
Current sample: 1995 to 2004  
Number of observations: 10

Mean of dep. var. = -.019599      LM het. test = .939234E-02 [.923]  
Std. dev. of dep. var. = .125153      Durbin-Watson = .685418 [.001,.018]  
Sum of squared residuals = .232018E-02      Jarque-Bera test = .478423 [.787]  
Variance of residuals = .290023E-03      Ramsey's RESET2 = 10.8098 [.013]  
Std. error of regression = .017030      F (zero slopes) = 478.065 [.000]  
R-squared = .983541      Schwarz B.I.C. = -25.3515  
Adjusted R-squared = .981484      Log likelihood = 27.6541

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-.208484	.010180	-20.4799	[.000]
X1	.916158	.041901	21.8647	[.000]

	PDS	PGDPFC	PM
1995	1.00000	1.00000	1.00000
1996	1.03594	1.07677	1.01794
1997	0.98001	1.17791	1.07058
1998	1.17825	1.29266	1.05091
1999	-0.67081	1.31223	1.06770
2000	1.11830	1.31667	1.13417
2001	1.11677	1.39029	1.10519
2002	1.10041	1.43183	1.01191
2003	0.69340	1.48295	1.00665
2004	1.01225	1.50088	1.02281

PDS on PGDPFC, PM)  
=====

=====  
Equation 46  
=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
Number of observations: 9

Mean of dep. var. = -.028830      LM het. test = 3.65621 [.056]  
Std. dev. of dep. var. = .141477      Durbin-Watson = 2.95200 [.881,.987]  
Sum of squared residuals = .145418      Jarque-Bera test = 1.51644 [.468]  
Variance of residuals = .020774      Ramsey's RESET2 = 1.15124 [.325]  
Std. error of regression = .144132      F (zero slopes) = .708015 [.428]  
R-squared = .091854      Schwarz B.I.C. = -3.59649  
Adjusted R-squared = -.037881      Log likelihood = 5.79372

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	.032689	.087485	.373654	[.720]
X1	-.298395	.354626	-.841436	[.428]

ZZZ PDS on PGDPFC (0.8 imposed),PM: log-lin  
 =====

Equation 47  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y2  
 Number of observations: 9

Mean of dep. var. = -.193763	LM het. test = 0. [1.00]
Std. dev. of dep. var. = .207579	Durbin-Watson = 1.20064 [.094,.094]
Sum of squared residuals = .344712	Jarque-Bera test = 4.44029 [.109]
Variance of residuals = .043089	Ramsey's RESET2 = .850706E+38 [.000]
Std. error of regression = .207579	Schwarz B.I.C. = -.811155
R-squared = 0.	Log likelihood = 1.90977
Adjusted R-squared = 0.	

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-.193763	.069193	-2.80032	[.023]

	YAFS	GDPFCV
1995	46554.00000	1326385.00000
1996	54067.00000	1486958.00000
1997	57274.00000	1604173.00000
1998	58745.00000	1763915.00000
1999	62318.00000	1821850.00000
2000	60517.00000	1918964.00000
2001	63745.00000	2069568.00000
2002	65116.00000	2166615.00000
2003	65810.00000	2301288.00000
2004	70045.00000	2460882.00000

ZZZ YAFS on GDPFCV and T: log  
 =====

Equation 48  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = 11.0032	LM het. test = .318819 [.572]
-----------------------------	-------------------------------

Std. dev. of dep. var. = .116521                      Durbin-Watson = 3.09909 [.876,1.00]  
 Sum of squared residuals = .426733E-02          Jarque-Bera test = .224017 [.894]  
 Variance of residuals = .609619E-03          Ramsey's RESET2 = 1.72363 [.237]  
 Std. error of regression = .024690              F (zero slopes) = 96.7215 [.000]  
    R-squared = .965077                      Schwarz B.I.C. = -21.1535  
    Adjusted R-squared = .955099              Log likelihood = 24.6074

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-10.9102	4.84489	-2.25191	[.059]
X1	1.56071	.350498	4.45283	[.003]
T	-.064955	.022794	-2.84968	[.025]

	DEP	PI	KT	KMS
1995	288456.00000	1.00000	1463665.25000	4085869.00000
1996	310712.46875	1.04459	1514864.25000	4201931.00000
1997	340398.00000	1.10973	1570429.25000	4306249.00000
1998	371231.96875	1.16492	1616379.25000	4415061.00000
1999	398005.12500	1.19890	1661618.25000	4504627.00000
2000	434330.21875	1.23538	1723668.25000	4573526.00000
2001	463776.96875	1.25815	1787244.25000	4643327.00000
2002	468138.75000	1.22559	1843296.25000	4719601.00000
2003	489243.68750	1.24717	1894127.25000	4821130.00000
2004	524915.25000	1.28476	1941898.25000	4939249.00000

	KBC	KA
1995	152655.78125	298732.43750
1996	156388.78125	311550.43750
1997	165238.78125	315479.43750
1998	174264.78125	319303.43750
1999	178914.78125	319177.43750
2000	185015.78125	319985.43750
2001	191882.78125	322467.43750
2002	199391.78125	326499.43750
2003	204691.78125	330484.43750
2004	207442.78125	331449.43750

DEP on PI\*(KT+KBC+KMS+KA): log  
 =====

Equation 49  
 =====

Method of estimation = Ordinary Least Squares

Dependent variable: Y1  
 Current sample: 1995 to 2004  
 Number of observations: 10

Mean of dep. var. = 12.9032                      LM het. test = 1.53523 [.215]  
 Std. dev. of dep. var. = .202753                  Durbin-Watson = .575460 [.000,.008]  
 Sum of squared residuals = .411328E-02          Jarque-Bera test = .747845 [.688]  
 Variance of residuals = .514160E-03          Ramsey's RESET2 = 16.7085 [.005]  
 Std. error of regression = .022675              F (zero slopes) = 711.581 [.000]  
    R-squared = .988882                      Schwarz B.I.C. = -22.4886  
    Adjusted R-squared = .987493              Log likelihood = 24.7912

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-8.21177	.791584	-10.3738	[.000]
X1	1.32976	.049850	26.6755	[.000]

ZZZ DEP on PI\*(KT+KBC+KMS+KA) (1.0 imposed): log  
=====

Equation 50  
=====

Method of estimation = Ordinary Least Squares

Dependent variable: Y2  
Current sample: 1995 to 2004  
Number of observations: 10

Mean of dep. var. = -2.97554	LM het. test = 0. [1.00]
Std. dev. of dep. var. = .054378	Durbin-Watson = .119039 [.000,.000]
Sum of squared residuals = .026613	Jarque-Bera test = 1.16598 [.558]
Variance of residuals = .295700E-02	Ramsey's RESET2 = .850706E+38 [.000]
Std. error of regression = .054378	Schwarz B.I.C. = -14.3040
R-squared = 0.	Log likelihood = 15.4553
Adjusted R-squared = 0.	

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-2.97554	.017196	-173.037	[.000]

# F

---

## SIMULATING THE HCZ5 MODEL: WINSOLVE BATCH FILES

### F.1: HCZ5HIST.LOG: CHECKING CONSISTENCY WITH HISTORICAL DATA

```
WinSolve log file
@
@ -----
@ Open the model HCZ5.TXT
@ -----
@
ModelOpen c:\SIMREGIO\HCZ5\HCZ5.txt
@
@ -----
@ Open the database, HCZ5.SDF (actual 1995-2004; missing 2005-2020)
@ -----
@
DataOpen c:\SIMREGIO\HCZ5\HCZ5.sdf
@
@ -----
@ Set the solution algorithm options (Newton)
@ -----
@
SolveOpt alg gausseidel itmax 100 itp 100 maxerr 100 errval 1.0 abs 0.001 pct 0.001
alpha 1.0 beta 1.0
@
@ -----
@ Run a single-equation simulation within sample, with data taking precedence
@ -----
@
SolveRun Run1 per 1998-2004 single
@
@ -----
@ Set the implicit residuals to the values generated by Run1
@ -----
@
AdjReset all Run1
@
@ -----
@ Run a dynamic simulation, using the above altered adjustments
@ -----
@
SolveRun Run2 per 1998-2004 dynsys noragged
@
EndLog
```

## F.2: HCZ5PROD0.LOG: PROJECTING EXOGENOUS VARIABLES OUT-OF-SAMPLE

```

WinSolve log file
@
@ -----
@ Open model HCZ5.TXT
@ -----
@
ModelOpen C:\SIMREGIO\HCZ5\HCZ5.txt
@
@ -----
@ Open the database, HCZ5.SDF (actual 1995-2004; missing 2005-20)
@ -----
@
DataOpen C:\SIMREGIO\HCZ5\HCZ5.sdf
@
@ -----
@ Set the solution algorithm options (Gauss)
@ -----
@
SolveOpt alg gausseidel itmax 100 itp 100 maxerr 100 errval 1.0 abs 0.001 pct 0.001
alpha 1.0 beta 1.0
@
@ -----
@ Run a single-equation simulation within sample, with data taking precedence
@ -----
@
Alt GDPEV0 2
Alt KGINFO 2
Alt KRTRIRD0 2
Alt KMS0 2
Alt KTO 2
Alt KTRAIN0 2
@
SolveRun Run1 per 1998-2004 single
@
@ Note: Run1 should reproduce the within sample curve fits
@
@ -----
@ Set the implicit residuals to the values generated by Run1
@ -----
@
AdjReset all Run1
@
@ -----
@ Run a dynamic simulation, using the above altered adjustments
@ -----
@
Alt GDPEV0 2
Alt KGINFO 2
Alt KRTRIRD0 2
Alt KMS0 2
Alt KTO 2
Alt KTRAIN0 2
@
SolveRun Run2 per 1998-2004 dynsys noragged
@
@ Note: Run2 should reproduce the within sample historical data
@

```

```

@ -----
@ Project the exogenous variables from 2005 to 2020 -----
@ -----
@
@ Explanatory note on projections:
@
@ A projection with ldv=1.0 is one where the values set in HERDATA are
@ projected unchanged into the
@
@ Where ldv is greater than unity (e.g., 1.03), the annual growth rate
@ in the projected exogenous variable is 3%
@
@ Where ldv is less than than unity (e.g., 0.95), the annual growth rate
@ in the projected exogenous variable is -5%
@
@ -----
@ Make projections of the implicit behavioural residuals (or adjustments)
@ -----
@
AdjProj OT      per 2005-2020 ldv  1.0
AdjProj IT      per 2005-2020 ldv  1.0
AdjProj LT      per 2005-2020 ldv  1.0
AdjProj POT     per 2005-2020 ldv  1.0
AdjProj PM      per 2005-2020 ldv  1.0
AdjProj WT      per 2005-2020 ldv  1.0
AdjProj OMS     per 2005-2020 ldv  1.0
AdjProj IMS     per 2005-2020 ldv  1.0
AdjProj LMS     per 2005-2020 ldv  1.0
AdjProj POMS    per 2005-2020 ldv  1.0
AdjProj WMS     per 2005-2020      cnst 0.0
AdjProj OBC     per 2005-2020 ldv  1.0
AdjProj IBC     per 2005-2020 ldv  1.0
AdjProj LBC     per 2005-2020 ldv  1.0
AdjProj POBC    per 2005-2020 ldv  1.0
AdjProj WBC     per 2005-2020      cnst 0.0
AdjProj OA      per 2005-2020 ldv  1.0
AdjProj LA      per 2005-2020 ldv  1.0
AdjProj KA      per 2005-2020 ldv  1.0
AdjProj WA      per 2005-2020      cnst 0.0
AdjProj WG      per 2005-2020      cnst 0.0
AdjProj POG     per 2005-2020      cnst 0.0
AdjProj LFPR    per 2005-2020 ldv  1.0
AdjProj CONS    per 2005-2020 ldv  1.0
AdjProj PIT     per 2005-2020 ldv  1.0
AdjProj PIBC    per 2005-2020 ldv  1.0
AdjProj PIMS    per 2005-2020 ldv  1.0
AdjProj PIA     per 2005-2020 ldv  1.0
AdjProj PIG     per 2005-2020 ldv  1.0
AdjProj PIH     per 2005-2020 ldv  1.0
AdjProj PCONS   per 2005-2020 ldv  1.0
AdjProj PG      per 2005-2020      cnst 0.0
AdjProj PDS     per 2005-2020 ldv  1.0
AdjProj PYAFS   per 2005-2020      cnst 0.0
AdjProj PYFN    per 2005-2020      cnst 0.0
AdjProj RGTRU   per 2005-2020      cnst 0.0
AdjProj GND     per 2005-2020 ldv  1.0
AdjProj YAFS    per 2005-2020 ldv  1.0
@
AdjSave C:\SIMREGIO\HCZ5\HCZ5ADJP.sdf
@
@ -----
@ Project remaining exogenous variables from 2005 to 2020
@ -----

```



```

@
@ -----
@ Projection of altered time trends out of sample (judgemental)
@ -----
@
@ T: Standard time trend (projected in standard way)
@
DataProj T      per 2005-2020 cnst 14 trnd 1.00
@
@ -----
@
@ TOT: Trend output growth in manufacturing (calibrated 1.94% pa)
@
DataProj TOT    per 2005-2020 cnst 14 trnd 0.50
@
@ TT: Manufacturing HN technical progress (calibrated 4.73% pa)
@
DataProj TT     per 2005-2020 cnst 14 trnd 1.00
@
@ -----
@
@ TOBC: Trend output growth in Building & Construction (calibrated -10.94% pa)
@
DataProj TOBC   per 2005-2020 cnst 14 trnd 0.01
@
@ Building & Construction HN technical progress (calibrated -3.06% pa)
@
DataProj TBC    per 2005-2020 cnst 14 trnd -0.75
@
@ -----
@
@ TOMS: Trend output growth in market services (calibrated 1.22% pa)
@
DataProj TOMS   per 2005-2020 cnst 14 trnd 1.75
@
@ TMS: Market services HN technical progress (calibrated 2.29% pa)
@
DataProj TMS    per 2005-2020 cnst 14 trnd 1.00
@
@ -----
@
@ TLFPR: Trend change in labour force participation rate (calibrated: ZZZ%pts pa)
@
DataProj TLFPR per 2005-2020 cnst 14 trnd 0.00
@
@ -----
@
@ TOA: Trend change in productivity growth in agriculture (calibrated: ZZZ% pa)
@
DataProj TOA    per 2005-2020 cnst 14 trnd 1.00
@
@ TLA: Trend change in agricultural employment (calibrated ZZZ% pa)
@
DataProj TLA    per 2005-2020 cnst 14 trnd 0.50
@
@ TKA: Trend change in agricultural employment (calibrated ZZZ% pa)
@
DataProj TKA    per 2005-2020 cnst 14 trnd 1.00
@
@ -----
@
@ Trend in ratio of YAFS to GDP (calibrated at ZZZ% pa)

```

```

@
DataProj TYAFS per 2005-2020 cnst 14 trnd 1.00 {YAFS/GDPMV trend growth}
@
@ -----
@
DataProj BTPRNE per 2005-2020 ldv 1.0
DataProj BPRES per 2005-2020 ldv 1.0
@
DataProj CZKBGF per 2005-2020 ldv 1.0
DataProj CZKDM per 2005-2020 ldv 1.0
DataProj CZKESP per 2005-2020 ldv 1.0
DataProj CZKFRF per 2005-2020 ldv 1.0
DataProj CZKGBP per 2005-2020 ldv 1.0
DataProj CZKILI per 2005-2020 ldv 1.0
DataProj CZKNLG per 2005-2020 ldv 1.0
DataProj CZKSEK per 2005-2020 ldv 1.0
DataProj CZKUSD per 2005-2020 ldv 1.0
@
DataProj BGIP per 2005-2020 ldv 1.03
DataProj DKIP per 2005-2020 ldv 1.03
DataProj FNIP per 2005-2020 ldv 1.03
DataProj FRIP per 2005-2020 ldv 1.03
DataProj GEIP per 2005-2020 ldv 1.03
DataProj HUIP per 2005-2020 ldv 1.03
DataProj ITIP per 2005-2020 ldv 1.03
DataProj NLIP per 2005-2020 ldv 1.03
DataProj NWIP per 2005-2020 ldv 1.03
DataProj OEIP per 2005-2020 ldv 1.03
DataProj PTIP per 2005-2020 ldv 1.03
DataProj RUIP per 2005-2020 ldv 1.03
DataProj SDIP per 2005-2020 ldv 1.03
DataProj SPIP per 2005-2020 ldv 1.03
DataProj SWIP per 2005-2020 ldv 1.03
DataProj UKIP per 2005-2020 ldv 1.03
DataProj USIP per 2005-2020 ldv 1.03
@
DataProj IGV per 2005-2020 ldv 1.03
DataProj IHGV per 2005-2020 ldv 1.03
DataProj ISMGV per 2005-2020 ldv 1.03
@
DataProj GREVK per 2005-2020 ldv 1.0
DataProj GTRABR per 2005-2020 ldv 1.0
DataProj GTTI per 2005-2020 ldv 1.0
DataProj GTYPROP per 2005-2020 ldv 1.0
DataProj GV_DIF per 2005-2020 ldv 1.0
@
DataProj LG per 2005-2020 ldv 1.0
@
DataProj OGNW per 2005-2020 ldv 1.0
@
DataProj POA per 2005-2020 ldv 1.03
DataProj BGP per 2005-2020 ldv 1.03
DataProj FRP per 2005-2020 ldv 1.03
DataProj GEP per 2005-2020 ldv 1.03
DataProj ITP per 2005-2020 ldv 1.03
DataProj NLP per 2005-2020 ldv 1.03
DataProj SDP per 2005-2020 ldv 1.03
DataProj SPP per 2005-2020 ldv 1.03
DataProj UKP per 2005-2020 ldv 1.03
DataProj USP per 2005-2020 ldv 1.03
@
DataProj RGENW per 2005-2020 ldv 1.0
@

```

DataProj	RGSRUBPD	per	2005-2020	ldv	1.0
DataProj	RGSUBPD	per	2005-2020	ldv	1.0
DataProj	RGSUBO	per	2005-2020	ldv	1.0
DataProj	RGTEM	per	2005-2020	ldv	1.0
DataProj	RGTEPD	per	2005-2020	ldv	1.0
DataProj	RGTREP	per	2005-2020	ldv	1.0
DataProj	RGTRK	per	2005-2020	ldv	1.0
DataProj	RGTRSW	per	2005-2020	ldv	1.0
DataProj	RGTYC	per	2005-2020	ldv	1.0
DataProj	RGTYP	per	2005-2020	ldv	1.0
DataProj	RGTYSOCE	per	2005-2020	ldv	1.0
DataProj	RGTYSOCW	per	2005-2020	ldv	1.0
DataProj	RGREVO	per	2005-2020	ldv	1.0
@					
DataProj	STDISE	per	2005-2020	ldv	1.0
DataProj	STDISI	per	2005-2020	ldv	1.0
DataProj	STDISIV	per	2005-2020	ldv	1.0
@					
DataProj	DIFGDPE	per	2005-2020	ldv	1.0
DataProj	DIFGDPEV	per	2005-2020	ldv	1.0
DataProj	DIFGREVC	per	2005-2020	ldv	1.0
@					
DataProj	WIGME	per	2005-2020	ldv	1.0
DataProj	WIOME	per	2005-2020	ldv	1.0
@					
DataProj	KIHP	per	2005-2020	ldv	1.0
DataProj	KYCTREP	per	2005-2020	ldv	1.0
@					
DataProj	YASA	per	2005-2020	ldv	1.0
DataProj	YCURAT	per	2005-2020	ldv	1.0
DataProj	YFN	per	2005-2020	ldv	1.0
@					
DataProj	RGDI	per	2005-2020	ldv	1.0
DataProj	RRSA	per	2005-2020	ldv	1.0
@					
DataProj	N	per	2005-2020	ldv	1.005
DataProj	NELD	per	2005-2020	ldv	1.005
DataProj	NWORK	per	2005-2020	ldv	1.005
@					
DataProj	SEARAT	per	2005-2020	ldv	1.0
DataProj	SEBCRAT	per	2005-2020	ldv	1.0
DataProj	SEMSRAT	per	2005-2020	ldv	1.0
DataProj	SETRAT	per	2005-2020	ldv	1.0
@					
DataProj	DEPARAT	per	2005-2020	ldv	1.0
DataProj	DEPBCRAT	per	2005-2020	ldv	1.0
DataProj	DEPGRAT	per	2005-2020	ldv	1.0
DataProj	DEPMSRAT	per	2005-2020	ldv	1.0
DataProj	DEPTRAT	per	2005-2020	ldv	1.0
@					
DataProj	DEPRAT	per	2005-2020	ldv	1.0
@					
@	Project CSF-related variables				
@					
DataProj	DETAMSPH	per	2005-2020	ldv	1.0
DataProj	DETAMSPI	per	2005-2020	ldv	1.0
DataProj	DETAMSPR	per	2005-2020	ldv	1.0
DataProj	DETATPH	per	2005-2020	ldv	1.0
DataProj	DETATPI	per	2005-2020	ldv	1.0
DataProj	DETATPR	per	2005-2020	ldv	1.0
DataProj	DETATQH	per	2005-2020	ldv	1.0

```

DataProj DETATQI per 2005-2020 ldv 1.0
DataProj DETATQR per 2005-2020 ldv 1.0
@
DataProj LOCEC per 2005-2020 ldv 1.0
DataProj LOCDP per 2005-2020 ldv 1.0
DataProj LOCPR per 2005-2020 ldv 1.0
@
DataProj TFRACT per 2005-2020 ldv 1.0
DataProj TRITPR per 2005-2020 ldv 1.0
DataProj TRIMSPR per 2005-2020 ldv 1.0
DataProj TRIAEC per 2005-2020 ldv 1.0
DataProj TRIADP per 2005-2020 ldv 1.0
DataProj TRIAPR per 2005-2020 ldv 1.0
@
@ GECSFEC_RE is the EC funding in real 2006 euro
@
DataProj GECSFEC_RE per 2005-2020 ldv 1.0
@
DataProj GTRSFPR per 2005-2020 ldv 1.0
DataProj IGVCSEFPR per 2005-2020 ldv 1.0
DataProj RDCOFIN per 2005-2020 ldv 1.0
DataProj RGTRSF per 2005-2020 ldv 1.0
DataProj RIGVCSF per 2005-2020 ldv 1.0
DataProj RTRIT per 2005-2020 ldv 1.0
@
@ Project real non-ROP R&D investments (RRANDD) unchanged
@
DataProj RRANDD per 2003-2020 ldv 1.0
@
@ Project private contribution and R&D fraction
@
DataProj RPTVTRI per 2003-2020 ldv 1.0
DataProj RRDTCSF per 2003-2020 ldv 1.0
@
@ Project trade weights
@
DataProj XW1 per 2005-2020 ldv 1.0
DataProj XW2 per 2005-2020 ldv 1.0
DataProj XW3 per 2005-2020 ldv 1.0
DataProj XW4 per 2005-2020 ldv 1.0
DataProj XW5 per 2005-2020 ldv 1.0
DataProj XW6 per 2005-2020 ldv 1.0
DataProj XW7 per 2005-2020 ldv 1.0
DataProj XW8 per 2005-2020 ldv 1.0
DataProj XW9 per 2005-2020 ldv 1.0
@
DataProj MW1 per 2005-2020 ldv 1.0
DataProj MW2 per 2005-2020 ldv 1.0
DataProj MW3 per 2005-2020 ldv 1.0
DataProj MW4 per 2005-2020 ldv 1.0
DataProj MW5 per 2005-2020 ldv 1.0
DataProj MW6 per 2005-2020 ldv 1.0
DataProj MW7 per 2005-2020 ldv 1.0
DataProj MW8 per 2005-2020 ldv 1.0
DataProj MW9 per 2005-2020 ldv 1.0
@
DataProj XWBG per 2005-2020 ldv 1.0
DataProj XWDK per 2005-2020 ldv 1.0
DataProj XWFN per 2005-2020 ldv 1.0
DataProj XWFR per 2005-2020 ldv 1.0
DataProj XWGE per 2005-2020 ldv 1.0
DataProj XWHU per 2005-2020 ldv 1.0
DataProj XWIT per 2005-2020 ldv 1.0

```

```
DataProj XWNL      per 2005-2020 ldv  1.0
DataProj XWNW      per 2005-2020 ldv  1.0
DataProj XWOE      per 2005-2020 ldv  1.0
DataProj XWPT      per 2005-2020 ldv  1.0
DataProj XWRU      per 2005-2020 ldv  1.0
DataProj XWSD      per 2005-2020 ldv  1.0
DataProj XWSP      per 2005-2020 ldv  1.0
DataProj XWSW      per 2005-2020 ldv  1.0
DataProj XWUK      per 2005-2020 ldv  1.0
DataProj XWUS      per 2005-2020 ldv  1.0
@
DataProj DS        per 2005-2020 cnst 0.0
@
@ -----
@ Save projected data in H CZ5PRO.SDF
@ -----
@
DataSave C:\SIMREGIO\HCZ5\HCZ5PROD0.sdf
@
EndLog
```

### F.3: HCZ5PROD1.LOG: GENERATING BASELINE PROJECTION FROM 2005 TO 2020

```

WinSolve log file
@
@ HCZ5PROD1.LOG
@
@ -----
@ Open model HCZ5.TXT
@ -----
@
ModelOpen C:\SIMREGIO\HCZ5\HCZ5.txt
@
@ -----
@ Open data file of historical 1995-2004 data, with exovars and
@ adjustments projected to 2020 (from HCZ5PROD0.LOG)
@ -----
@
DataOpen C:\SIMREGIO\HCZ5\HCZ5PROD0.sdf
@
@ -----
@ Set simulation algorithm to Gausseidel or Newton, with tight convergence criteria
@ -----
@
SolveOpt alg Newton itmax 500 itp 100 maxerr 100 errval 1.000 abs 0.001 pct 0.01 al-
pha 1.000 beta 1.000
@
@ -----
@ Dynamic projection from 1998 to 2020, using projected exovars and adjs
@ Run1 reproduces the within sample data for 1998-2004, and projects out of sample
@ -----
@
@
Alt GDPEV0 2
Alt KGINF0 2
Alt KRTRIRD0 2
Alt KMS0 2
Alt KT0 2
Alt KTRAIN0 2
@
SolveRun Run1 per 1998-2020
@
@ Run1 reproduces the within sample data for 98-04, and projects out of sample
@
@ Dynamic projection from 1998 to 2020, using simulated stocks
@ (KGINF0, KTRAIN0, KRTRIRD0, KT0, KMS0 and GDPEV0) from Run1 above
@
@ Replicate Run1 simulation, but with derived stocks (KGINF0, etc)
@ set exogenously from Run1 simulated values (i.e., as in baseline projection)
@
Datareset GDPEV0 Run1
Datareset KGINF0 Run1
Datareset KRTRIRD0 Run1
Datareset KMS0 Run1
Datareset KT0 Run1
Datareset KTRAIN0 Run1
Fix GDPEV0 per 1998-2020

```

```
Fix KGINFO per 1998-2020
Fix KRTRIRD0 per 1998-2020
Fix KMS0 per 1998-2020
Fix KT0 per 1998-2020
Fix KTRAIN0 per 1998-2020
Alt GDPEVO 1
Alt KGINFO 1
Alt KRTRIRD0 1
Alt KMS0 1
Alt KT0 1
Alt KTRAIN0 1
@
SolveRun Run2 dynsys per 1998-2020
@
ViewNew
>
spread per 1998-2020 file c:\simregio\HCZ5\HCZ5Baseline.XLS
GDPM sol%dif Run1 Run1
GDPM sol Run1 Run1
LPROD sol%dif Run1 Run1
LPROD sol Run1 Run1
LPRT sol%dif Run1 Run1
LPRT sol Run1 Run1
LPRMS sol%dif Run1 Run1
LPRMS sol Run1 Run1
LFPR sol Run1 Run1
UR sol Run1 Run1
L sol%dif Run1 Run1
L sol Run1 Run1
LT sol%dif Run1 Run1
LT sol Run1 Run1
LMS sol%dif Run1 Run1
LMS sol Run1 Run1
ULCT sol%dif Run1 Run1
ULCT sol Run1 Run1
SAVRAT sol Run1 Run1
GBORR sol Run1 Run1
NTSVR sol Run1 Run1
;
@
DataSave c:\simregio\HCZ5\HCZ5BASE.SDF
@
EndLog
```



---

## POLICY SHOCKS: H CZ5 MODEL WINSOLVE BATCH FILES

### G.1: H CZ5OW.LOG: SHOCK TO COMPONENTS OF WORLD OUTPUT

```
WinSolve log file
@
@ Open model H CZ5.TXT
@
ModelOpen c:\sim\H CZ5\H CZ5.txt
@
@ Open data file of historical 1995-2004 data, extended to 2020
@
DataOpen c:\sim\H CZ5\H CZ5BASE.sdf
@
@ Set simulation algorithm to Newton, with tight convergence criteria
@
SolveOpt alg Newton itmax 100 itp 100 maxerr 100 errval 1.000 abs 0.001 pct 0.001
alpha 1.000 beta 1.000
@
@ Dynamic projection from 2004 to 2020, using projected exovars and adjs
@
SolveRun Run1 per 2004-2020 dynsys
@
AdjProj DKIP per 2005-2020 cnst 0.1 mult
AdjProj FNIP per 2005-2020 cnst 0.1 mult
AdjProj FRIP per 2005-2020 cnst 0.1 mult
AdjProj GEIP per 2005-2020 cnst 0.1 mult
AdjProj ITIP per 2005-2020 cnst 0.1 mult
AdjProj BGIP per 2005-2020 cnst 0.1 mult
AdjProj UKIP per 2005-2020 cnst 0.1 mult
AdjProj USIP per 2005-2020 cnst 0.1 mult
AdjProj NLIP per 2005-2020 cnst 0.1 mult
AdjProj NWIP per 2005-2020 cnst 0.1 mult
AdjProj OEIP per 2005-2020 cnst 0.1 mult
AdjProj SPIP per 2005-2020 cnst 0.1 mult
AdjProj SDIP per 2005-2020 cnst 0.1 mult
AdjProj HUIP per 2005-2020 cnst 0.1 mult
AdjProj PTIP per 2005-2020 cnst 0.1 mult
AdjProj RUIP per 2005-2020 cnst 0.1 mult
AdjProj SWIP per 2005-2020 cnst 0.1 mult
@
SolveRun Run2 per 2004-2020 dynsys
@
EndLog
```



**G.2: HCZ5LG.LOG: SHOCK TO PUBLIC EMPLOYMENT**

```
WinSolve log file
@
@ Open model HCZ5.TXT
@
ModelOpen C:\sim\HCZ5\HCZ5.txt
@
@ Open data file of historical 90-99 data, extended to 2020
@
DataOpen C:\sim\HCZ5\HCZ5BASE.SDF
@
@ Set simulation algorithm to Newton, with tight convergence criteria
@
SolveOpt alg Newton itmax 100 itp 100 maxerr 100 errval 1.000 abs 0.001 pct 0.001
alpha 1.000 beta 1.000
@
@ Dynamic projection from 1998 to 2020, using projected exovars and adjs
@
SolveRun Run1 per 2004-2020 dynsys
@
@ Make 1% cut to LG
@
AdjDefType int
AdjType LG mult
AdjProj LG per 2005-2020 cnst 0.01
@
SolveRun Run2 per 2004-2020 dynsys
@
EndLog
```

**G.3: HCZ5IGV.LOG: SHOCK TO PUBLIC INVESTMENT**

```
WinSolve log file
@
@ Open model HCZ5.TXT
@
ModelOpen c:\sim\HCZ5\HCZ5.txt
@
@ Open data file of historical 1995-2004 data, extended to 2020
@
DataOpen c:\sim\HCZ5\HCZ5BASE.SDF
@
@ Set simulation algorithm to Newton, with tight convergence criteria
@
SolveOpt alg Newton itmax 100 itp 100 maxerr 100 errval 1.000 abs 0.001 pct 0.001
alpha 1.000 beta 1.000
@
@ Dynamic projection from 2004 to 2020, using projected exovars and adjs
@
SolveRun Run1 per 2004-2020 dynsys
@
AdjDefType int
AdjType IGV mult
AdjProj IGV per 2005-2020 cnst 0.1
```

```
@
SolveRun Run2 per 2004-2020 dynsys
@
EndLog
```

#### G.4: HCZ5PRICE.LOG SHOCK TO ALL EXOGENOUS PRICES

```
WinSolve log file
@
@ Open model HCZ5.TXT
@
ModelOpen c:\sim\HCZ5\HCZ5.txt
@
@ Open data file of historical 1995-2004 data, extended to 2020
@
DataOpen c:\sim\HCZ5\HCZ5BASE.SDF
@
@ Set simulation algorithm to Newton, with tight convergence criteria
@
SolveOpt alg Newton itmax 100 itp 100 maxerr 100 errval 1.000 abs 0.001 pct 0.001
alpha 1.000 beta 1.000
@
@ Dynamic projection from 2004 to 2020, using projected exovars and adjs
@
SolveRun Run1 per 2004-2020 dynsys
@
AdjDefType int
AdjType POA mult
AdjProj POA per 2005-2020 cnst 0.1
@
AdjDefType int
AdjType BGP mult
AdjProj BGP per 2005-2020 cnst 0.1
@
AdjDefType int
AdjType FRP mult
AdjProj FRP per 2005-2020 cnst 0.1
@
AdjDefType int
AdjType GEP mult
AdjProj GEP per 2005-2020 cnst 0.1
@
AdjDefType int
AdjType ITP mult
AdjProj ITP per 2005-2020 cnst 0.1
@
AdjDefType int
AdjType NLP mult
AdjProj NLP per 2005-2020 cnst 0.1
@
AdjDefType int
AdjType SDP mult
AdjProj SDP per 2005-2020 cnst 0.1
@
AdjDefType int
AdjType SPP mult
AdjProj SPP per 2005-2020 cnst 0.1
```

```
@
AdjDefType int
AdjType UKP mult
AdjProj UKP per 2005-2020 cnst 0.1
@
AdjDefType int
AdjType USP mult
AdjProj USP per 2005-2020 cnst 0.1
@
SolveRun Run2 per 2004-2020 dynsys
@
EndLog
```





```

DataEdit RTRIT per 2007-2020
60 60 60 60 60 60 60 60 60
0 0 0 0 0
@
@ -----
@ Aid to productive sector: private (RPVTRI: percentage of GECSFEC_RE)
@ -----
@
DataEdit RPVTRI per 2007-2020
10.53 10.53 10.53 10.53 10.53 10.53 10.53 10.53 10.53
0 0 0 0 0
@
@ -----
@ Aid to productive sector: R&D (RRDTCSF: percentage)
@ -----
@
DataEdit RRDTCSF per 2007-2020
22.78 22.78 22.78 22.78 22.78 22.78 22.78 22.78 22.78
0 0 0 0 0
@
@ -----
@ Analysis of the impacts of NSRF 2007-2013
@
@ Assumptions on externality elasticities are in HCZ5.TXT. See model
@ listing for actual values used in simulations
@
@ Defaults are shown below
@
@ ETATQI = 0.20 (Output (OT) wrt infrastructure)
@ ETATQH = 0.20 (Output (OT) wrt human capital)
@ ETATQR = 0.05 (Output (OT) wrt R&D)
@
@ ETATPI = 0.10 (TFP wrt infrastructure)
@ ETAMSPI = 0.10 (TFP wrt infrastructure)
@
@ ETATPH = 0.10 (Labour embodied wrt human capital)
@ ETAMSPH = 0.10 (Labour embodied wrt human capital)
@
@ ETATPR = 0.05 (TFP wrt R&D)
@ ETAMSPR = 0.025 (TFP wrt R&D)
@
@ Assumption on NSRF finance after 2013 (EC, DP and PR)
@ Abrupt cut-off after 2013
@
@ Phase in externalities over 5 years from year 2007
@
DataEdit DETATQH per 2006-2020
0.0 0.20 0.40 0.60 0.80 1 1 1 1 1 1 1 1 1 1 1
DataEdit DETATQI per 2006-2020
0.0 0.20 0.40 0.60 0.80 1 1 1 1 1 1 1 1 1 1
DataEdit DETATQR per 2006-2020
0.0 0.20 0.40 0.60 0.80 1 1 1 1 1 1 1 1 1 1
@
DataEdit DETATPH per 2006-2020
0.0 0.20 0.40 0.60 0.80 1 1 1 1 1 1 1 1 1 1
DataEdit DETATPI per 2006-2020
0.0 0.20 0.40 0.60 0.80 1 1 1 1 1 1 1 1 1 1
DataEdit DETATPR per 2006-2020
0.0 0.20 0.40 0.60 0.80 1 1 1 1 1 1 1 1 1 1
@
DataEdit DETAMSPH per 2006-2020
0.0 0.20 0.40 0.60 0.80 1 1 1 1 1 1 1 1 1 1

```

```

DataEdit DETAMSPI per 2006-2020
0.0 0.20 0.40 0.60 0.80 1 1 1 1 1 1 1 1 1 1 1
DataEdit DETAMSPR per 2006-2020
0.0 0.20 0.40 0.60 0.80 1 1 1 1 1 1 1 1 1 1
@
@ -----
@           Dynamic projection of nsrf impacts: 2007-2020
@ -----
@
Datareset GDPEV0   Run1
Datareset KGINF0   Run1
Datareset KRTRIRD0 Run1
Datareset KMS0     Run1
Datareset KT0      Run1
Datareset KTRAIN0  Run1
Fix GDPEV0   per 1998-2020
Fix KGINF0   per 1998-2020
Fix KRTRIRD0 per 1998-2020
Fix KMS0     per 1998-2020
Fix KT0      per 1998-2020
Fix KTRAIN0  per 1998-2020
Alt GDPEV0   1
Alt KGINF0   1
Alt KRTRIRD0 1
Alt KMS0     1
Alt KT0      1
Alt KTRAIN0  1
@
SolveRun Run2  dynsys per 1998-2020
@
@ Examine NSRF impacts for a selection of variables
@
@ [1] Baseline no-NSRF projection: GDPM, L, UR
@
@ [2] NSRF funding injections: GECSFRAE, GECSFRAP
@
@ [3] Impacts on NSRF-induced stocks: KGINFR, KTRNR, KRTRIRDR
@
@ [4] Aggregate macroeconomic impacts: GDPM, L, UR, LPROD
@
@ [5] Sectoral impacts: Manufacturing, B&C and Market Services
@
@ [6] Expenditure impacts: CONS, I
@
@ [7] Wage/price impacts: PGDPFC, POT, POMS, PCONS, WT
@
@ [8] Impacts on trade balance and PSBR: NTSVR, GBORR
@
ViewNew
>
spread per 2006-2020 file c:\simregio\HCZ5\NSRF_Nplus2_V01.XLS
GDPM      sol%dif      Run1 Run1
L         sol%dif      Run1 Run1
UR        sol          Run1 Run1
GECSFRAE  sol Latest Run1
GECSFRAP  sol Latest Run1
KGINFR    pct Latest Run1
KTRNR     pct Latest Run1
KRTRIRDR  pct Latest Run1
GDPM      sol%dif      Latest Latest
GDPM      sol%dif      Run1  Run1
GDPM      pct Latest Run1

```

```
L          pct Latest Run1
L          dif Latest Run1
UR         dif Latest Run1
LPROD     pct Latest Run1
OT        pct Latest Run1
LT        pct Latest Run1
LT        dif Latest Run1
LPRT      pct Latest Run1
OBC       pct Latest Run1
LBC       pct Latest Run1
LBC       dif Latest Run1
LPRBC     pct Latest Run1
OMS       pct Latest Run1
LMS       pct Latest Run1
LMS       dif Latest Run1
LPRMS     pct Latest Run1
CONS      pct Latest Run1
I         pct Latest Run1
PGDPFC    pct Latest Run1
POT       pct Latest Run1
POMS      pct Latest Run1
PCONS     pct Latest Run1
WT        pct Latest Run1
WT        sol%dif   Latest Latest
WT        sol%dif   Run1   Run1
NTSVR     dif Latest Run1
GBORR     dif Latest Run1
RDEBT     dif Latest Run1
;
@
EndLog
```



*Variable notation: Names*

<b>GDPM</b>	Aggregate gross domestic product (constant prices)
<b>L</b>	Aggregate employment
<b>UR</b>	Unemployment rate
<b>GECSFRAE</b>	<i>CP+CF</i> funding as a percentage of GDP (EC element)
<b>GECSTRAP</b>	<i>CP+CF</i> funding as a percentage of GDP (EC+domestic element)
<b>KGINGR</b>	"Stock" of physical infrastructure
<b>KTRNR</b>	"Stock" of human capital
<b>LPROD</b>	Aggregate labour productivity
<b>OT</b>	GDP produced in manufacturing (constant prices)
<b>LT</b>	Employment in manufacturing
<b>LPRT</b>	Labour productivity in manufacturing
<b>ON</b>	GDP produced in market services (constant prices)
<b>LLN</b>	Employment in market services
<b>LPRN</b>	Labour productivity in market services
<b>CONS</b>	Household consumption (constant prices)
<b>I</b>	Total fixed investment (constant prices)
<b>PGDPFC</b>	Deflator of aggregate GDP
<b>POT</b>	Deflator of GDP in manufacturing
<b>PON</b>	Deflator of GDP in market services
<b>PCONS</b>	Deflator of household consumption
<b>WT</b>	Average annual earnings in manufacturing
<b>NTSVR</b>	Net trade surplus expressed as a percentage of GDP
<b>GBORR</b>	Public sector borrowing expressed as a percentage of GDP