STRUCTURE AND PROPERTIES OF THE TURKISH HERMIN MODEL - HTR5

Dr. John Bradley

Eser Pirgan Matur

Pınar Yaşar

Murat Vardal

A. Sema Bahçeci

Economic Modeling Department

General Directorate of Economic Modeling and Strategic Research

State Planning Organization

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Contacts for communications

A. Sema Bahçeci (Project Coordinator)
State Planning Organization
Economic Modeling Department
Necatibey Cad. No.108
Phone: +90 312 294 60 17
Fax: +90 312 294 60 77
E-mail : sbahceci@dpt.gov.tr

Dr. John Bradley (Consultant)
EMDS - Economic Modeling and Development Strategies
14 Bloomfield Avenue, Dublin 8, Ireland
Phone: +353-1-454 5138
Fax: +353-1-497 0001
E-mail : john.bradley@iol.ie

Eser Pirgan Matur
State Planning Organization
Economic Modeling Department
E-mail : epirgan@dpt.gov.tr

Pınar Yaşar
State Planning Organization
Economic Modeling Department
E-mail : pyasar@dpt.gov.tr

Murat Vardal
State Planning Organization
Economic Modeling Department
E-mail : mvardal@dpt.gov.tr

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1. INTRODUCTION

Turkey acquired candidate status after the Helsinki summit in December 1999 and the negotiation talks started in October 2005. So, Turkey is now engaged in the convergence process for full membership of the European Union. The Turkish convergence process affects all aspects of the economy and needs to be analysed in an economy-wide, systematic way. In particular, the economy needs to be modelled within a framework that examines the links between the evolving sectoral structure of the economy and the overall performance of the aggregate macro economy. Different types of models can be used to analyse the convergence process, but are usually in the form of macroeconomic models that are based on standard macroeconomic theory and econometric research findings. One such modeling framework is the so-called HERMIN model, which specifically studies structural changes that are induced by such policy shifts as trade liberalisation, an increase in foreign direct investment inflow, rapid technological change and EU-financed structural programmes of public investment in infrastructural and human-capital development. The HERMIN model framework has been widely used to analyse the real convergence process of the less advanced countries in the EU (Bradley et al., 1995a; ESRI, 1997; Bradley, 2006).

There is already a strong motivation for constructing a Turkish variant of the HERMIN model, even though Turkey does not yet have access to the large-scale development funding (i.e., Structural Funds) that are made available to EU member states. Since the 1960s, Turkey has implemented a series of national development plans that were prepared by the State Planning Organization (SPO) in order to improve economic and social welfare. These plans were prepared with the assistance of macro-modeling tools that were similar to contemporary models in the rest of the world[1]. Hence, quantitative investigation of the impacts of policy decisions was already an important part of the agenda of the Economic Modeling Department of the SPO for many years prior to becoming an EU candidate country.

However, the study of development processes in the medium term (i.e., over planning time horizons of between five and ten years) makes demands on models that require specific design features. It was specifically to address these challenges that the HERMIN model framework was developed. For example, HERMIN models have been used within the EU to study the likely macroeconomic impact of the implementation of the Single European Market (SEM) in 1992 (ESRI, 1997). They have also been used to examine the likely impacts of the EU Structural Funds on the EU peripheral economies, starting with the so-called "old" member states (Greece, Ireland, Portugal and Spain), and later extending to the twelve "new" member states that joined in 2004 and 2007[2]. A useful way of modeling such systemic policy shifts is to note that as trade liberalisation proceeds, major sub-components of the manufacturing sector as well as some aspects of market services switch from being essentially non-tradeable to being internationally tradeable. In the case of the Single European Market (SEM), 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 to infrastructure. In the case of EU Structural Funds, the changes come about through the effects of improved physical infrastructure and human capital of productivity and output, mainly in those parts of manufacturing and market services that are internationally tradeable.

This paper describes the first version of a Turkish variant of the HERMIN model framework at the national level. Later papers will use the model to explore how the Turkish economy is modernising and re-structuring as it integrates increasingly into the Single European Market, and as it moves towards full EU membership. The paper is organized as follows.

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[1] For the economic modeling experience of SPO, see SPO (1991), SPO (1995), SPO (2000), SPO (2008).
[2] See Bradley (2006) for a survey.

Section 2 provides a description of the Turkish economy, making use of the database that has been specially developed to support the HERMIN model. As well as being of interest in its own right, this material introduces the sectoral structure used in the model, and explores the type of restructuring that has been going on over the last two decades.

In Section 3 the theoretical background of the HERMIN model framework is presented and the assumptions used in the Turkish HERMIN model are described. It will be seen that there are two main benefits of using a fairly standardised modeling framework like HERMIN. First, it has been specially designed to examine shifts in the economy that are mainly on the production, or supply side. So, although there is a fairly standard treatment of the main expenditure or demand aspects of the economy, the supply side is disaggregated into five sectors: manufacturing, building and construction, market services, agriculture, and non-market (or public) services. Second, the use of a relatively standardised framework will facilitate comparisons to be made between the Turkish process of real convergence and how these same processes have been working out in the less advanced "old" and "new" EU member states.

In Section 4, the methods of calibration of the model's behavioural equations are described, based on a database of time series of Turkish national accounting and other data from the period 1987-2006[3]. Although it is possible to obtain data prior to the year 1987, the period of the last twenty years (i.e., 1987-2006) was considered appropriate for the development and calibration of the model. Any longer period would run the risk of uncovering major structural changes that would invalidate use of the model for the analysis of policy shocks (i.e., the so-called Lucas critique). Indeed, the process of model calibration pointed to the need to restrict the data sample even further, and focus on the last ten years in some cases.

Section 5 describes how the Turkish HERMIN model was implemented, tested, and used to construct the preliminary baseline projection of Turkish economy covering the years 2007-2020. This section also introduces the special software used to simulate the model, i.e., the WINSOLVE modeling software developed by Pierse (1998). The baseline projection is then used to make a number of policy and other shocks, which are designed to investigate the behavioural responses in the model.

Section 6 describes some of the transmission mechanisms of public investment policy that are built into the new HTR5 model. These mechanisms handle three main types of public investment: physical infrastructure (e.g., roads, ports, telecommunications, etc.); human resources (education, training, etc.); and direct assistance provided by transfers to private firms (e.g., support for R&D, management training, capital grants, etc.). In addition to the direct "implementation" or Keynesian impacts, these mechanisms also account for spill-over (or externality) benefits that come from improved stocks of infrastructure, human capital and R&D.

Section 7 concludes and sets out the agenda of policy research that might be undertaken using the new HERMIN model. Furthermore, areas where the model can be extended so as to capture more accurately the Turkish development process are described.

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[3] The data set has not been extended to 2007 for the first version of the paper, as Turkish Statistical Institute (TURKSTAT) changed the base year of national accounts data during the preparation of the first draft of the HERMIN Model for Turkey in 2008 and did not announce the 2007 figures of the old series.

2. A portrait of the Turkish economy: 1987-2006

Import substitution industrialization strategy was the main development strategy of many developing economies including Turkey during the 1960's and 1970's. By the end of the 1970's, the Turkish economy started to face severe economic difficulties due to the inherent weaknesses of the import substitution industrialization strategy as well as due to external shocks such as oil price increases. These difficulties manifested themselves as problems in financing the balance of payments (BOP) and investments. It became obvious that the import substitution industrialization strategy had reached its limits and that it had become unsustainable by the late 1970s. Economic problems accompanied by political unrest led Turkey to shift its development strategy from import substitution industrialization to a more outward oriented development strategy in 1980[4].

Starting from 1980, a set of economic reforms was implemented. The main rationale behind these reforms was to change the system from import substitution with heavy state intervention toward export orientation with an emphasis on market-oriented policies (Senses, 1991). The main components of the immediate reform agenda were trade liberalization and domestic financial liberalization along with a comprehensive price reform.

Trade liberalization was characterized by export promotion with strong subsidy components and gradual import liberalization through elimination of quantity restrictions followed by reduction of tariff rates. Moreover, export promotion was supported by competitive devaluations and severe depression of wage incomes. Therefore, it is important to note that the effects of trade reforms did not take place in isolation but in the larger context macro policy and relative price changes including exchange rates and wages. Furthermore, due to the regressive distributional aspects of this phase, the macroeconomic adjustment contained politically unsustainable elements (Celasun, 1994).

The export oriented growth strategy, which was initially built on wage suppression, depreciation of the domestic currency, and immense export subsidies, reached its economic and political limits by the end of 1980s (Boratav and Yeldan, 2006). By 1988, the economy displayed a stagflationary outlook signalling a need for further policy steps. In this environment, liberalization of trade was followed by capital account liberalization and declaration of TL's convertibility in 1989. However, these reforms, undertaken without building the necessary institutional infrastructure and attaining strong macroeconomic fundamentals, proved to be premature and created further economic problems.

In addition to high and sustained inflation, which had prevailed since early 1980s, the volatility of growth increased dramatically after 1989. Periods of rapid economic expansion alternated with periods of equally rapid decline in economic activity. Furthermore, growth was not only volatile, but was also well below its potential.

Another significant problem of this period was increasing fiscal deficits and thus borrowing requirements. Borrowing difficulties paved the way for 1994 financial crisis and led to a significant contraction of the Turkish economy. However, measures taken after the crisis were not sufficient to reveal the pressure on fiscal balances.

The financing need of the public sector put upward pressure on real interest rates and eventually pushed real interest rates well above sustainable levels. Interest payments became a significant burden on fiscal balances and further aggravated the financing problems. Besides, very high real interest rates attracted more and more resources to speculative and arbitrage activities, and distorted the working of financial markets and institutions. Private resources moved away from job-creating activities into financial investment. In sum, high real interest rates, together with a weak fiscal position, pushed

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[4] For a brief discussion of 1950-1980 period of Turkish economy, see Celasun (1994).

public finances onto an unsustainable path starting form the second half of the 1990s and rendered Turkey vulnerable to swings in market sentiment.

External events such as Asian crisis in 1997, Russian crisis in 1998 and the earthquake in the most important industrial region of Turkey in 1999 intensified the existing vulnerabilities of Turkish economy and made the inauguration of a new approach in macroeconomic management inevitable.

In this economic environment, a macro adjustment program aiming to free Turkey from chronic inflation, to improve fiscal balances and to enhance the prospects for growth through structural reforms, was adopted in December 1999. In this program, crawling peg exchange rate regime was adopted as the main pillar of the program and the key instrument for disinflation. However, the unconformity between the pre-determined exchange rate path and speed of disinflation led to a significant appreciation of domestic currency and revealed the weaknesses of the program. Even though a considerable decline in inflation and interest rates was achieved, together with a satisfactory growth rate in the first year of the program, Turkey faced two financial crises in November 2000 and February 2001, resulting from speculative attacks on TL and inherent problems in the banking sector. Following the second crisis, the crawling peg exchange rate regime had to be abandoned and in 2001 Turkey experienced its worst economic slowdown since 1945[5].

A new economic program, based on a floating exchange rate regime was adopted in May 2001. The main objective of this program was to increase financial and macroeconomic stability, to eliminate the effects of the crisis as soon as possible by restoring market confidence, to restore fiscal balance and to undertake structural measures. As a result of these policy actions, important progress in terms of macroeconomic balances and growth was achieved.

After the above presentation of the general background to the Turkish economy, the following sections will present a more detailed examination of Turkish economic performance, focusing on the last two decades. In line with the orientation of the new Turkish HERMIN model (subsequently referred to as HTR5, where the "5" refers to the five-sector disaggregation of the production side of the national accounts), emphasis will be put on the supply-side of the economy. Based on the data used in HTR5, output and employment, wages and prices, the degree of openness of the economy and fiscal developments will be analyzed.

2.1 GDP and per capita Income

On the production side of the national accounts, GDP is obtained as a sum of value added in agriculture, manufacturing, construction, market services, and government (or public) services. When the pattern of aggregate GDP data is analyzed, it can be seen that growth has been very volatile in the last two decades with an average of 4.2 percent (Figure 2.1).

In 1994, 1999 and 2001, Turkish economy experienced deep recessions. GDP contracted by 5.5 percent in 1994, by just over 4.5 percent in 1999 (the year in which a big earthquake occurred in Turkey), and by 7.5 percent in 2001. However, after the financial crisis in 2001, with political and macroeconomic stability, the help of decisively implemented structural reforms, as well as favourable international environment, the Turkish economy displayed a more stable growth path. Contrary to the prior expectations that the implemented tight fiscal and monetary policies would restrict growth, high growth rates were recorded and GDP growth rose to 7.2 percent annually on average in period of 2002-2006.

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[5] For a detailed discussion of the adjustment program and the following crises in 2000 and 2001, see Derviş et al.(2004), Ertuğrul and Selçuk (2001).

Figure 2.1: Growth Rate of Real GDP (%)
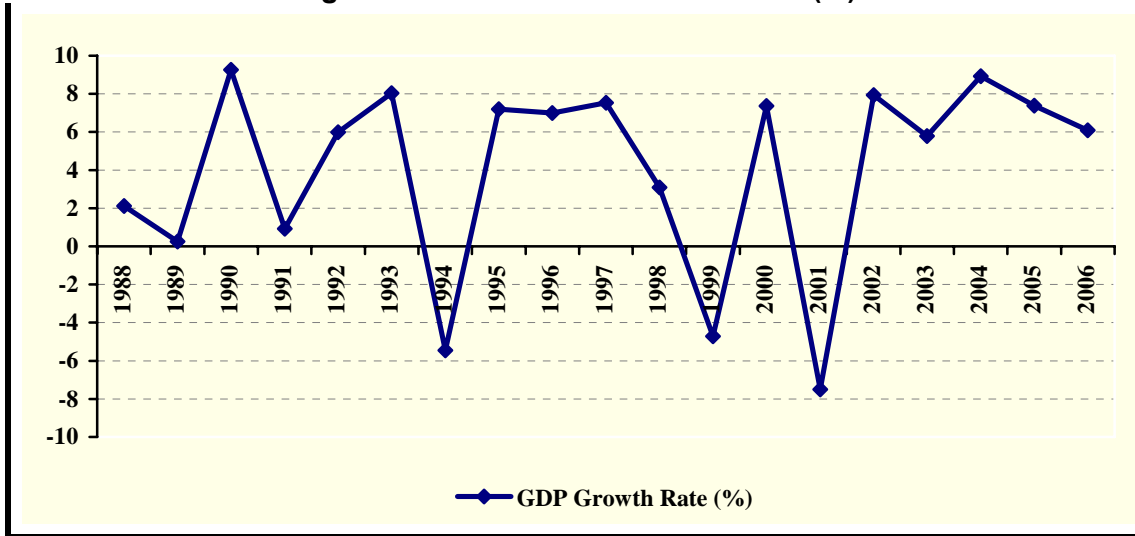
Figure 2.2 displays the level of real GDP between the years of 1987 and 2006. From the Figure, it is observed that the level of real GDP has doubled in 2006 compared to the year of 1987.

Figure 2.2: Index of Real GDP: 1987=100
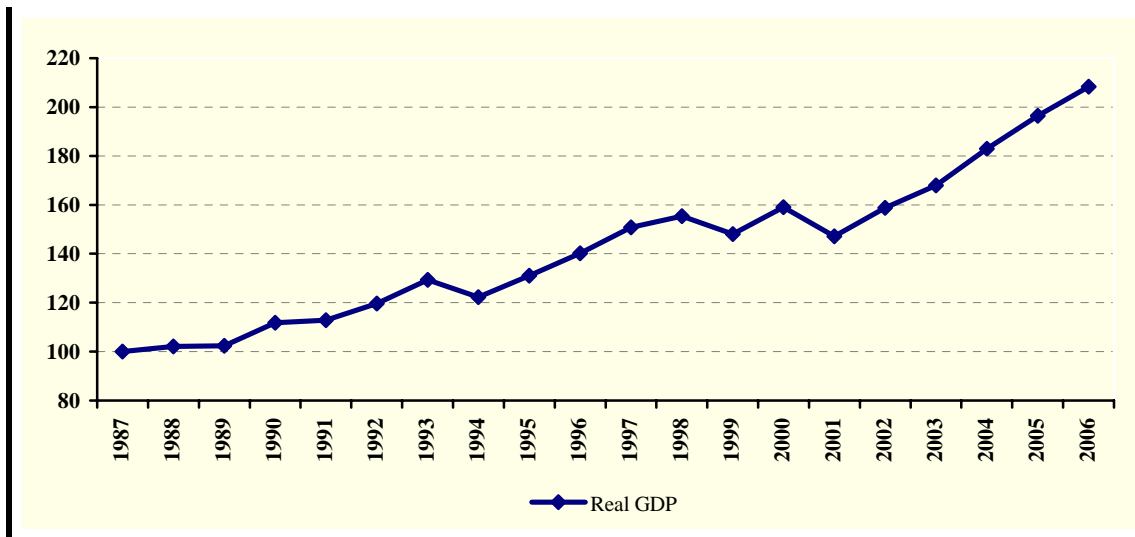
Figure 2.3 presents data on per capita GDP in dollar terms, where it is clearly seen that after the 2001 financial crisis, with the impact of high growth rates and appreciation of TL, per capita GDP increased rapidly. Per capita GDP, which was 2130 dollars in 2001, increased more than two-fold to 5519 dollars by 2006.

Figure 2.3: Nominal Per Capita GDP (In Dollars)
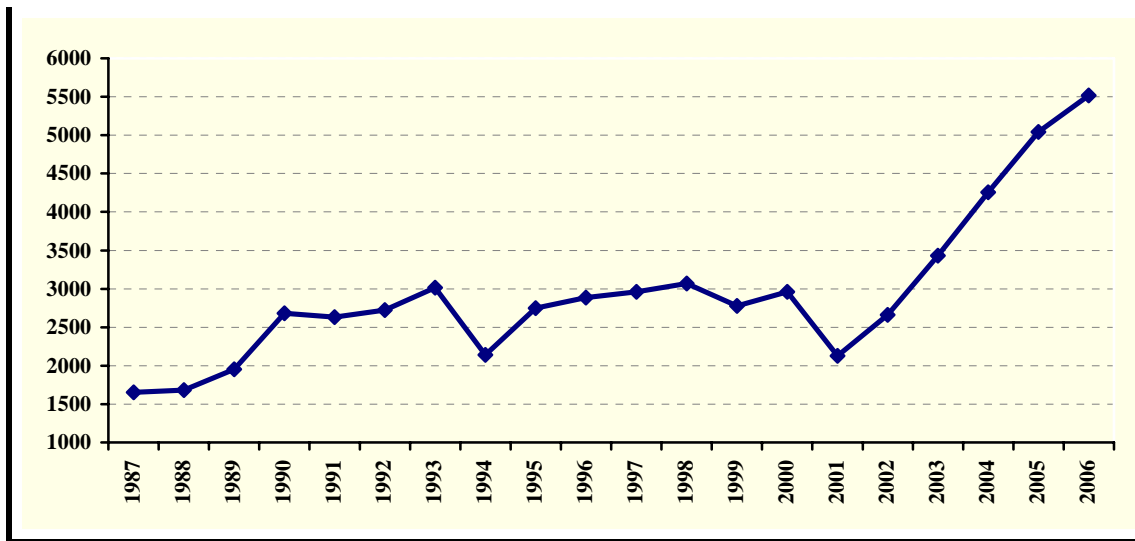
The growth in real per capita GDP can be broken down into growth in aggregate productivity (measured as GDP per employed person) and economic dependency (measured as total population as a fraction of numbers employed), as follows:

$$\frac{GDP}{Population} = \frac{GDP}{Employment} * \frac{Employment}{Population}$$

↓	↓	↓
GDP per capita	GDP per worker	Economic Dependency (inverse)

Economic dependency can further be broken down into an employment rate, a participation rate and an inverse age dependency rate as follows:

$$\frac{Employment}{Population} = \frac{Employment}{Labour\ Force} * \frac{Labour\ Force}{Working\ age} * \frac{Working\ age}{Population}$$

↓	↓	↓	↓
Economic Dependency (inverse)	Employment Rate	Participation Rate	Age Dependency (inverse)

Figure 2.4 shows real per capita GDP growth from 1989 to 2006. It also displays the breakdown of real GDP per capita growth into separate contributions from changes in productivity, the employment rate, the participation rate, and age dependency, respectively. It is obvious that average living standards have risen substantially since 2002. After the 2001 crisis, strong real per capita GDP growth has been supported mainly by high productivity

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growth. Throughout the whole period, the changes in labour force participation rate and employment rate have been modest, and sometimes negative.

Figure 2.4: Decomposition of Growth in Real GDP per capita
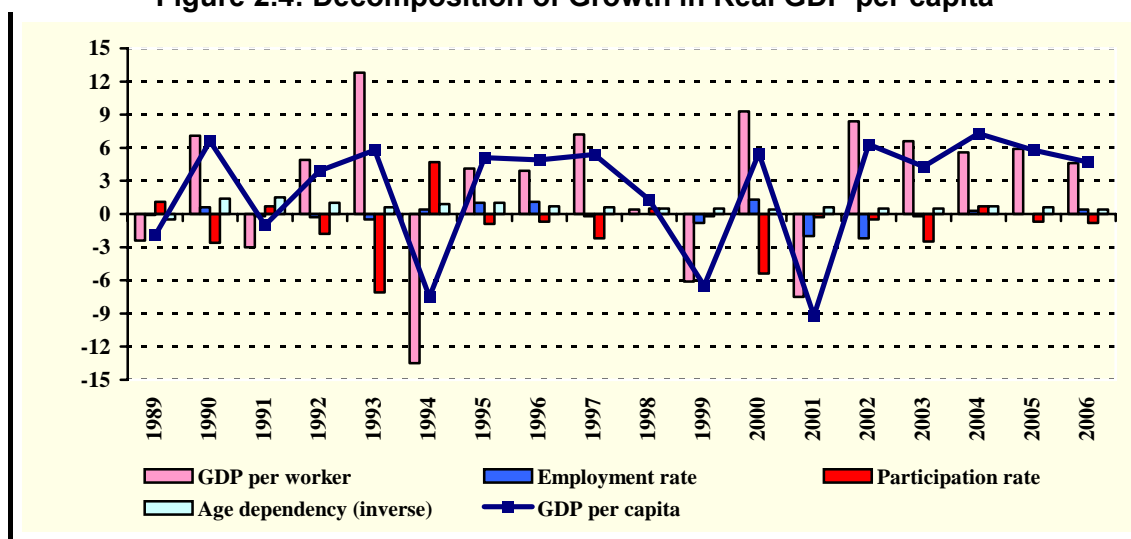
Source: Own Calculations

Overall the cumulative increase in real GDP per worker (economy-wide aggregate productivity) between 1989 and 2006 was over 48 percent, while the increase in living standards was 8 percent less. During this period, the lowest GDP per worker growth and real GDP per capita growth was recorded in 1994 and 2001 which correspond to the financial crises in Turkey. When the periods before and after the financial crisis in 2001 are compared, it can be observed that after the crisis, real per capita GDP growth and productivity growth rates are more than twice the corresponding rates of pre-crisis period. As growth has been mostly driven by productivity growth and job creation has been limited since 2002, the contribution of economic dependency to per capita GDP was negative in 2002-2006 period. The breakdown of per capita GDP for the mentioned periods is shown in Table 2.1.

Table 2.1: Breakdown of Cumulative Growth in GDP per capita (%)

	1989-2006	1989-2001	2002-2006
GDP per capita	40.7	12.4	28.3
-Productivity	48.4	17.2	31.2
-Economic Dependency	-7.7	-4.8	-2.8
Employment Rate	-1.6	0.1	-1.6
Participation	-18.1	-14.3	-3.8
Age Dependency	12.0	9.4	2.6

Source: Own Calculations

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2.2 The Labour Market

Labour market outcomes should be considered as the outcome of both demographic and economic factors, which act together to determine the supply and demand conditions in the labour market.

On the supply side of the labour market, demographic trends and labour force participation rates determine the size of the labour supply. Turkey has not completed its demographic transition yet, and the population growth rate, which has declined sharply since 1950s, is now around 1.3 percent. The growth rate of the working age population (15-64) is higher than the population growth rate, around 1.7 percent. Therefore one of the main characteristics of the Turkish labour market is the high growth rate of working age population and its young labour force.

Contrary to the favourable demographic trends in terms of labour supply, the labour force participation rate has been traditionally very low in Turkey compared to EU countries. The main reason behind this low participation rate is the very low female participation in the labour force. Furthermore, urbanization, internal migration and transformation in agriculture, which are closely associated, have exacerbated the problem. Women, who were mostly employed as unpaid family workers in rural areas, tend to drop out of the labour force after moving to urban areas. So, the labour force participation rate, which was rather low to start with, has been declining continuously (Figure 2.5).

Available evidence suggests that another reason behind low labour force participation rates in recent years may be the low job creation capacity of the economy (i.e., a "discouraged worker effect"). The number of people who are available to start working, but who are not actively seeking jobs, reached quite high levels especially in recent years.

Figure 2.5: Labour Force Participation Rate (%)
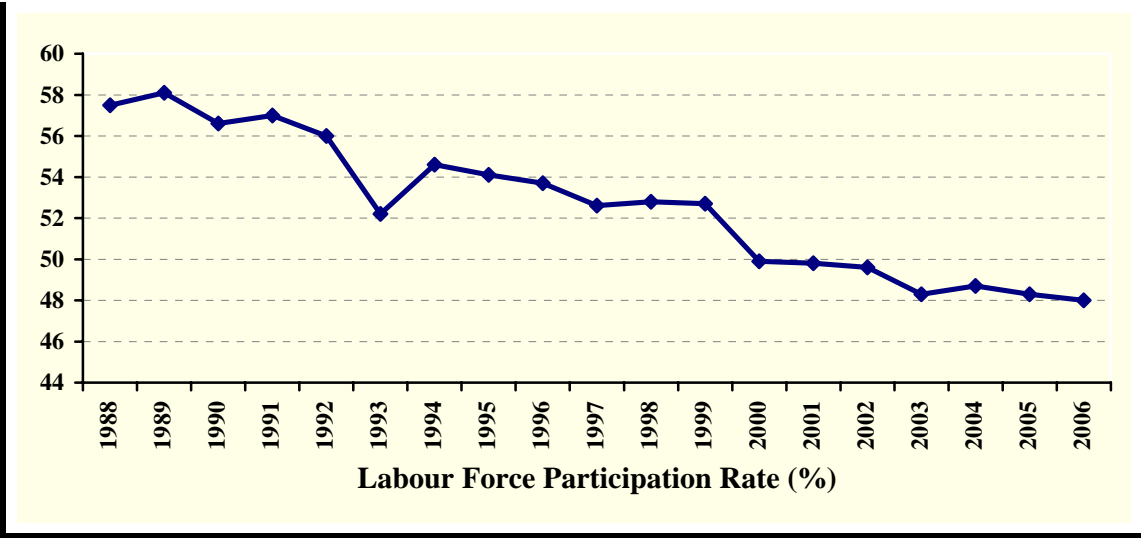
Source: TURKSTAT

The labour force participation rate, which was above 55 percent by the end of 1980s, declined to below 50 percent after 2001. This is a very low rate by EU standards. However, this trend is expected to be reversed in the near future, since a U-shaped pattern in female labour force participation emerges as countries urbanize, develop and educational

attainment of women increase[6]. Yet another factor that can potentially contribute to the increase in labour force participation rate is a possible reduction in the discouraged worker effect as the economy grows and more jobs are created[7].

With respect to the demand side of the labour market, it should be noted that the job creation capacity of the Turkish economy has been limited since 1980s. From 1981 to 2003 Brazil, Mexico, Argentina and Spain, which can be considered as comparator economies, all had faster employment growth, even though their GDP growth was lower (WB, 2006, p.16). Low job creation has been one of the most serious challenges facing the Turkish labour market in recent years.

From 1989 to 2000 only 3.4 million jobs were created in Turkey, even though the working age population increased by 12.2 millions during the same period. The strong growth performance after the 2001 crisis did not change this trend. Although the Turkish economy recorded remarkably high growth rates since 2002, the impact of economic growth on employment has remained rather limited. The cumulative GDP growth between 2002 and 2006 was 41.7 percent as opposed to cumulative employment growth of 3.7 percent, which corresponds to 807 thousand new jobs.

A key factor behind this poor job creation performance has been the high initial share of agriculture and the continuing transformation of the sector that results in a shift of labour out of agriculture. While 2.8 million jobs were created in the non-agricultural sectors during this period, employment decreased by 2 million in agriculture. Thus, contraction in agricultural employment restricted the increase in total employment to a great extent. This structural transformation of the economy is likely to continue at least for another decade creating a big challenge for job creation in Turkey.

Sectoral composition of employment confirms that the share of agricultural employment has declined considerably (Figure 2.6). The share of agricultural employment, which was 46 percent in 1988, declined to 27 percent in 2006.

Figure 2.6: Employment by Sectors (% Shares)
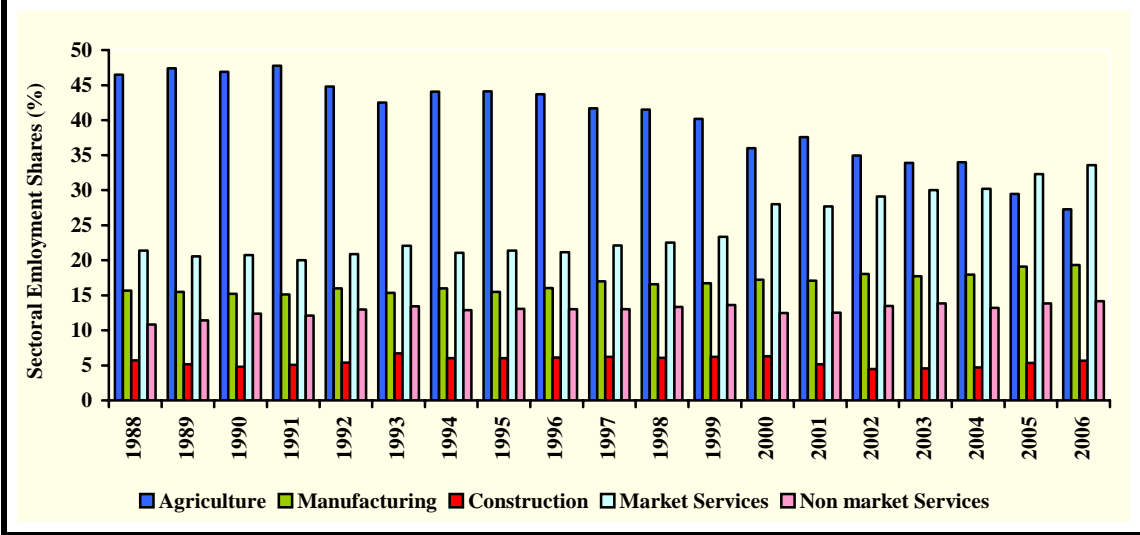
Source: TURKSTAT

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[6] The hypothesis of a u-shaped female labour force participation rate is well documented. For a study of the Turkish Case, see Tansel (2002).

[7] Labour force participation decisions are influenced by availability of sufficiently attractive employment opportunities (WB, 2000, p.2).

Employment in manufacturing has increased since 1987. However, the increase in manufacturing employment has not been as substantial as in market services and thus employment share in manufacturing has displayed a stable path during the period. On the other hand, the share of employment in market services, which was 21.4 percent in 1987, has increased considerably throughout the years and reached 33.6 percent in 2006. The transition from agriculture to services has played an important role in facilitating this substantial increase in the share of services employment.

When the unemployment data is analyzed, it is observed that the unemployment rate fluctuated between 6 percent and 11 percent in the 1988-2006 period (Figure 7). However, there has been an obvious structural break in this pattern starting with the financial crisis in 2001. Although the unemployment rate fluctuated below 8 percent in the previous period, it has never returned back to these levels after 2001. The 2001 crisis caused labour shedding in important sectors and forced firms to focus on driving up productivity levels, which has limited the potential for employment growth and led to a dramatic rise in the unemployment rate. The favourable economic environment in the Turkish economy after 2002 was not reflected in much net increase in employment numbers. Consequently, the unemployment rate remained around 10 percent since then.

However, a caveat is needed in interpreting the rise in the unemployment rate. As labour shifted out of agriculture into non-agricultural (urban) employment, people who had been classified as "employed" in agriculture are increasingly likely to be classified as "unemployed" in urban settings. Employment in agriculture often conceals "under employment". The strict definitions used by the EUROSTAT Labour Force Survey (LFS) may not have been used in earlier periods.

Figure 2.7: Unemployment Rate (%)

Source: TURKSTAT

2.3 Sectoral Composition of GDP

As a developing country, Turkey is still undergoing a structural transformation in its economy. The relative sizes of the main sectors are still far from the corresponding sizes in developed economies. In particular, the share of agricultural output is comparatively high whereas the size of market services is comparatively low. However, a process of decline in agriculture and rise in market services is likely to continue in the medium term.

When the sectoral structure of GDP is examined, it is observed that the share of agricultural production has been continuously declining. The share of agriculture in total value added which was around 18.5 percent in 1987, decreased to 12 percent in 2006.

Figure 2.8: Sectoral Shares in GDP (%)
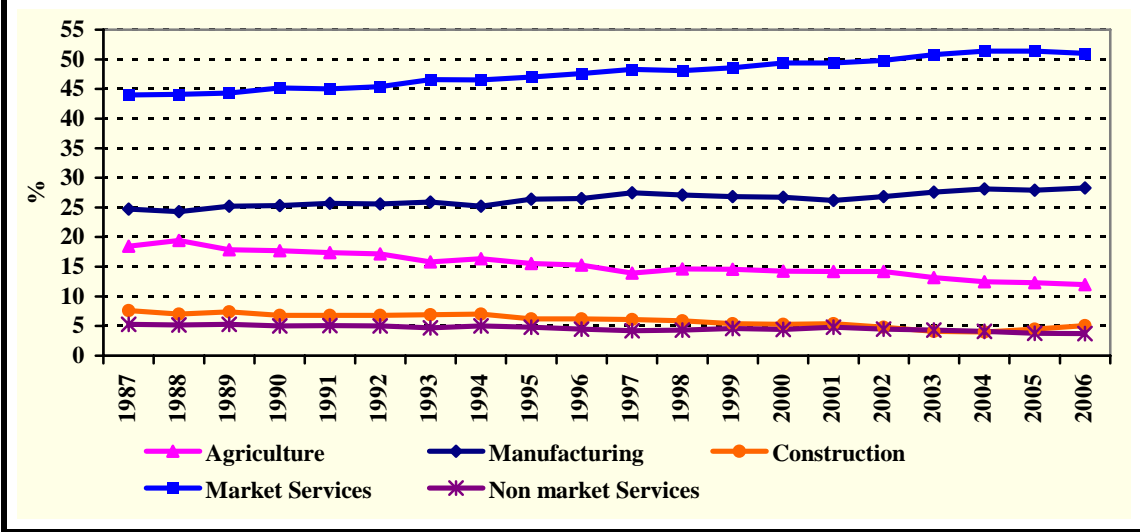
Contrary to the agriculture sector, share of manufacturing[8] sector in total value added has increased. The share, which was 24.7 percent in 1987, increased to 28.3 percent in 2006. In particular, the steady increase in the share of market services[9] is obvious. It was 44 percent in 1987 and increased to 51 percent in 2006. On the other hand, the share of construction, which was 7.6 percent in 1987, declined to 5.1 percent in 2006. Similarly, the share of non-market services, which was 5.3 per cent in 1987, decreased to 3.7 percent in 2006.

2.4 Productivity

Figure 2.9 shows the labour productivity by sectors for the 1987-2006 period. When the patterns are analyzed, it is observed that there was a productivity surge in manufacturing industry after the 2001 crisis. For the period of 2002-2006, productivity in Turkish manufacturing industry increased by 4.9 percent annually on average. This development has played an important role in high growth and export performance of Turkish economy since 2002. When the productivity levels in manufacturing and market services sectors are compared, it is obvious that over the given period productivity growth in market services was quiet low relative to productivity growth in manufacturing sector. Although manufacturing industry recorded high productivity increases in recent years, this productivity increase is still inadequate for rapid convergence to the EU.

Productivity in agriculture has considerably risen particularly in the last years. This productivity growth can be attributed mainly to the decline in agricultural employment rather than to a surge in agricultural output. Because of the massive hidden unemployment in agriculture, there is much space for further productivity increases.

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[8] Manufacturing sector covers both manufacturing and quarrying based on ISIC classification.

[9] Market services sector covers electricity, gas and steam, trade, transport and communication, financial institutions, ownership of dwellings, business and personal services, private non-profit institutions.

In the construction sector, in the years 2005 and 2006 productivity increased by 6.5 percent and 10.6 percent respectively. This increase can be attributed mostly to the high increase in output of construction sector.

Figure 2.9: Labour Productivity by Sectors
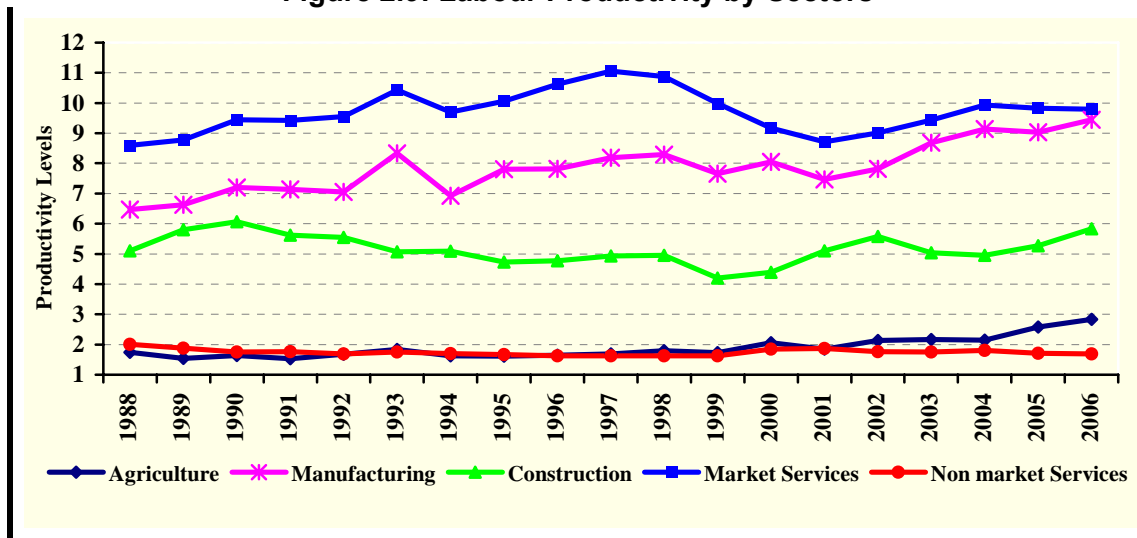
Source: Own Calculations

2.5 Unit Labour Costs

One of the most distinctive characteristics of Turkish labour markets is flexibility of real wages in all sectors. Until 2002, real wages closely follow the boom and bust cycles of the economy. In crises periods, the burden of adjustment basically falls on real wages.

Figure 2.10 presents the evolution of sectoral real unit labour costs[10] over the 1989-2006 period. It can be observed from the figure that the growth rates of real unit labour costs in different sectors are very similar, although the levels differ significantly. During the 1994 crisis, a historical decline of around 30 percent, was recorded in real unit labour costs. The labour market adjustment during the 1994 crisis was achieved through sharp decline in real wage rates so that the employment level was not affected to a great extent. However, when it comes to the 2001 crisis, it is noticed that the adjustment in real wages was less than in 1994, even though the crisis was deeper. Thus, there was also serious adjustment in terms of employment in the latter case.

When the dynamics of real wages are analyzed in a longer term perspective, it is observed that real wage increases follow the productivity increases very closely in manufacturing sector until 1980s. However, starting from the 1980s, the dynamics of real wages have changed to some extent and the connection between real wages and labour productivity weakened considerably (Voyvoda and Yeldan, 2001). This relation has further weakened after the 2001 crisis.

Although GDP growth in post-2001 period was accompanied by strong productivity increases, the gains in productivity were not fully transmitted into higher real wage rates. Thus, the growth rates of real unit labour costs have been fluctuating in a narrow band since 2002 and Turkey maintained its competitive advantage in terms of real unit labour costs. This feature of the labour market helped Turkey to sustain its competitiveness in external markets in spite of a strong appreciation of TL. However, this pattern cannot be expected to last for

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[10] Sectoral real unit labour costs are calculated as follows: Sectoral compensation of employees is divided by sectoral employment figures in order to get sectoral nominal unit labour costs. Afterwards, nominal unit labour costs are deflated by sectoral prices to reach the mentioned sectoral real unit labour costs.

ever, since gains in productivity are likely to be eventually reflected to real wages and therefore the living standards of labour.

Figure 2.10: Real Unit Labour Cost (% Change)
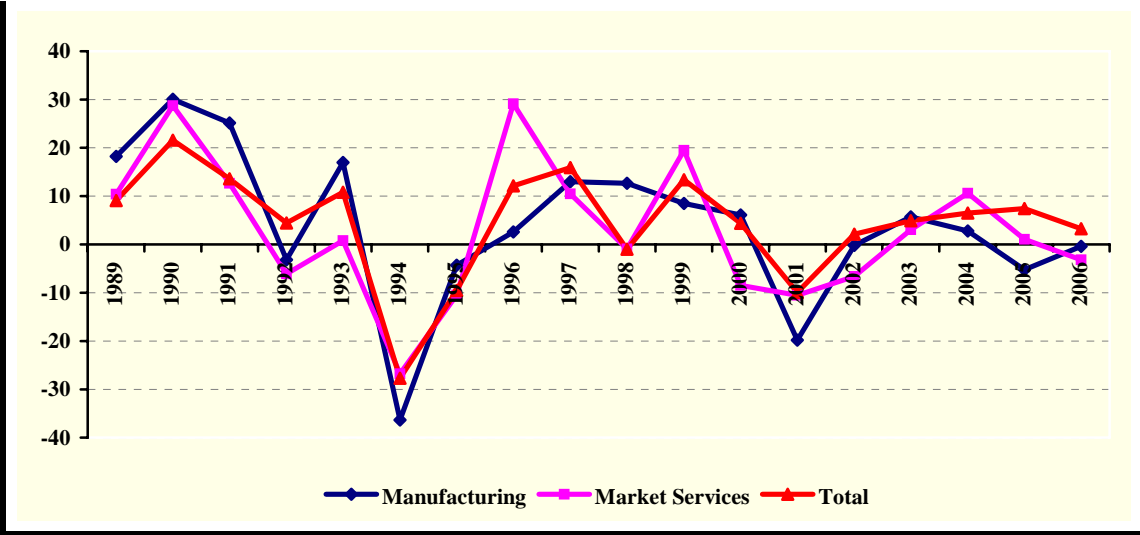
2.6 Price Behaviour and Inflation

The Turkish economy has experienced high and chronically persistent inflation in the last few decades. Although it has never reached hyperinflationary levels, dramatic figures were recorded especially in crisis periods. The common reasons behind the high inflation in Turkey since the late 1970s are usually considered to be the high public sector deficits, monetization of these deficits, persistent inflationary expectations of economic agents (inflationary inertia), increases in prices of major imported inputs especially crude oil prices and inflationary effects of rising exchange rates via increases in prices of imported goods (Diboğlu and Kibritçioğlu, 2003).

Since the late 1970s, several efforts have been undertaken to reduce inflation rates to reasonable levels. One of the main goals of the 1980 stabilization and liberalization program was the reduction of inflation. Initially, the program reached its goal in terms of a lower inflation, but after the general elections in 1983 inflation started to rise again. In the late 1980s disinflationary efforts were in the form of nominal anchoring, monetary tightening without any serious efforts on the fiscal side (Ertuğrul and Selçuk, 2001).

The 1990s were considered as "lost years" of the Turkish economy, characterized by macroeconomic instability and high inflation. The 1994 crisis intensified the existing inflation problem causing inflation to reach 3-digit levels. Among the price deflators, the price of manufacturing sector output recorded the highest increase (Table 2.2). After the 1994 financial crisis, new disinflation measures were introduced by the government. However these efforts in 1994 and 1998 failed to reduce the inflation rate to levels below 25 percent, as it had been in the early 1970s. The reasons behind the failure of disinflation efforts were mainly the macroeconomic instability and dominance of backward looking expectations of economic agents in Turkish economy. Until the end of 1999, high budget deficits, high inflation, volatile growth path and debt-interest vicious cycle constituted the main economic problems of the Turkish economy.

In 1999, with the introduction of a comprehensive stabilization program, crawling peg exchange rate regime was adopted and reduction of inflation to single digit levels was set as a goal. However, as a result of the weaknesses of the program and fragile financial markets, the program had to be abandoned with the crisis in 2001 and low inflation rates were not achieved.

After the 2001 crisis, favourable developments were achieved in terms of inflation. Central Bank independence was granted in 2001 and the Central Bank declared its primary policy objective as that of achieving and maintaining price stability. Until 2006, the Central Bank adopted an implicit inflation targeting regime and in 2006 there was a shift to official inflation targeting (CBRT, 2006). After 2001, considerable achievement has been attained in terms of price stability, and inflation declined to single digit levels in 2004 (Figure 2.11). Although inflation has increased moderately in 2006, this was mostly beyond the control of the Central Bank and driven by global developments regarding oil and food prices.

Figure 2.11: Consumer Price Index (2003=100) (% Change)
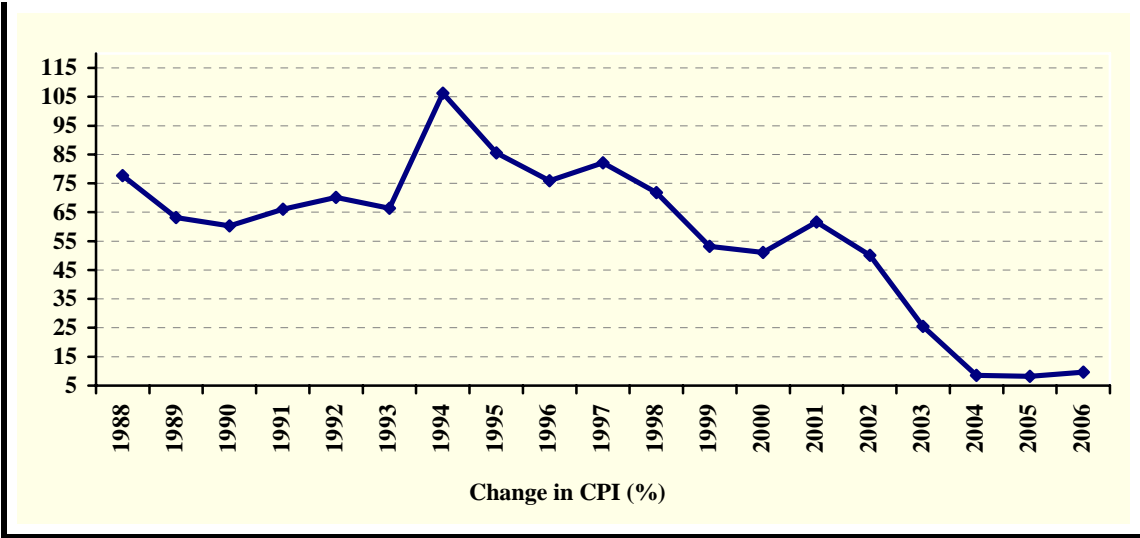
Source: TURKSTAT

Changes in sectoral price deflators and GDP deflators during the above mentioned period are presented in Table 2.2.

Table 2.2: Price Deflators, Annual Growth Rates (%)

	Agriculture	Manufacturing	Construction	Market Services	Government	Private Consumption	GDP
1988	55.3	78.1	93.8	66.7	64.9	58.9	69.3
1989	82.9	72.1	50.0	71.8	141.3	83.7	75.5
1990	70.6	49.0	57.3	55.1	103.5	59.8	58.3
1991	41.1	57.5	76.4	59.2	83.2	58.1	58.8
1992	63.5	59.7	58.9	64.3	77.1	63.6	63.7
1993	88.9	59.7	81.4	64.0	79.1	67.5	67.8
1994	97.2	123.9	84.6	107.5	67.6	103.2	106.5
1995	99.7	81.4	69.5	92.2	75.4	101.4	87.2
1996	95.8	67.3	90.1	77.4	100.4	67.8	77.8
1997	71.5	78.6	93.5	83.6	108.1	82.1	81.5
1998	101.7	60.5	77.9	73.2	79.9	83.0	75.7
1999	36.9	56.1	59.6	56.2	73.9	59.0	55.6
2000	42.5	51.9	42.4	55.1	41.1	50.0	49.9
2001	31.2	67.2	50.8	55.3	44.3	58.8	54.8
2002	39.6	37.7	30.7	51.6	49.2	40.6	44.1
2003	34.5	19.5	22.0	22.0	30.2	21.8	22.5
2004	12.6	11.5	16.1	8.9	15.0	7.9	9.9
2005	-2.3	9.7	14.0	4.6	11.3	6.1	5.4
2006	3.3	11.9	20.1	12.2	12.9	10.7	11.5

Source: Own Calculations

2.7 Openness and Trade

In the 1980s, the Turkish economy shifted to an export-led growth strategy and started to liberalize its trade. This shift of development strategy from inward orientation to outward orientation in the early 1980's was accompanied by a military regime, which resulted in the cessation of some civilian rights and suppression of wage increases. In this period exports were promoted through export subsidies, competitive depreciations in TL, suppression of real wages and accompanying contraction of domestic demand in order to increase the exportable surplus in the economy. As a result of these polices, exports increased more than three-fold by the end of 1980s.

However, contrary to expectations, a surge in investment in productive activities did not materialize during this period and the productive capacity of the economy could not be expanded enough to sustain high export growth rates into the coming period. In this period, in spite of acceleration of private investment, the composition of fixed investments was in favour of tourism and housing but against tradable sectors (Metin-Özcan et al., 2001). So the export boom in 1980s had been largely achieved via existing capacities built in pre-1980 inward-oriented growth era (Celasun, 1994). The pattern of accumulation observed in 1980s laid the ground for sluggish export performance in 1990s.

The 1990s were unfavourable not only in macroeconomic terms but also in terms of export performance. In this period, export performance could not be sustained due to lack of productive capacity in manufacturing, inability to undertake necessary investment to increase productive capacity, an exchange rate policy favouring appreciations in TL and increase in domestic demand. The underlying non-conformity between trade objectives and realized patterns of accumulation away from manufacturing during 1980s played a significant role in the failure to sustain export performance (Metin-Özcan et al., 2001).

One of the most prevailing developments in terms of trade policy in 1990s was the Customs Union Agreement with European Union, which came into effect in 1996. This agreement was a further step in terms of trade liberalization in Turkey and domestic markets were exposed

to more competitive pressures afterwards. With this agreement, the level of integration between Turkey and the EU economies increased considerably and as a result, Turkish exports to and imports from EU have displayed a significant increase.

Figure 2.12: Imports & Exports of Goods and Services as % of GDP
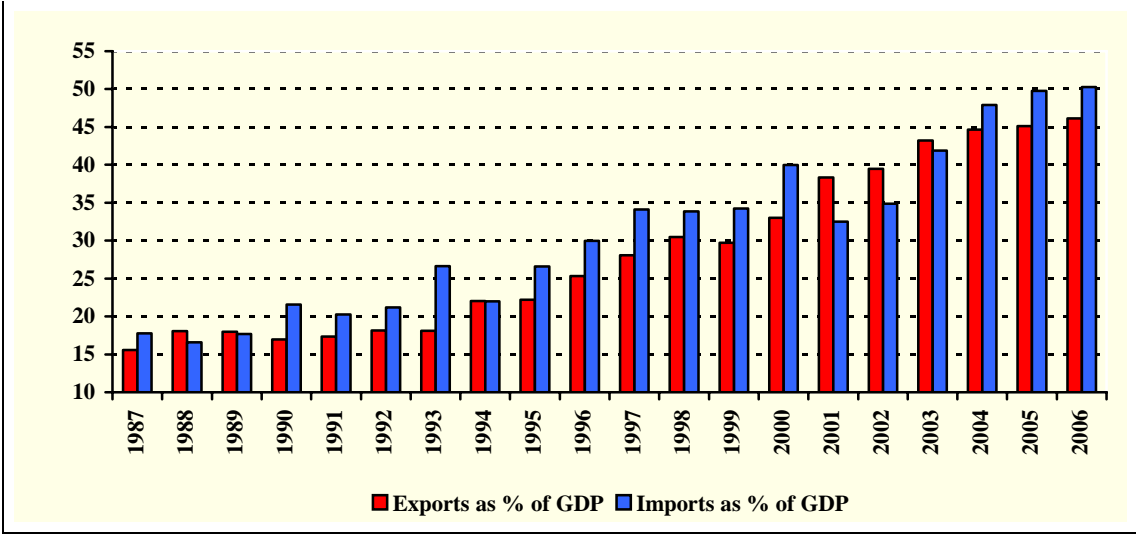
The 2001 crisis can be considered as another turning point for Turkish exports. The sharp decline of domestic demand in 2001 led manufacturers to focus on external markets, thus creating an initial impulse to exports. Starting from 2002, increasing productivity levels and a sharp decline in real unit labour costs helped the Turkish economy to make great progress in its export performance despite the appreciation of TL. Moreover, exports were driven by strong world demand as well. As a result of these, exports almost tripled between 2001 and 2006.

Together with these developments, imports have also risen considerably. Throughout the last decades, the Turkish economy has become more integrated into the world economy and its trade value has increased remarkably. As of 2006, the sum of imports (c.i.f) and exports (f.o.b) of goods was recorded as 225 billion dollars.

When the shares of imports and exports of goods and services in GDP are examined, it is seen that these figures increased from 17.8 percent (imports) and 15.6 percent (exports) in 1987 to 50.3 percent (imports) and 46.1 percent (exports) in 2006, respectively (Figure 2.12). Moreover, the structure of exports have changed in favour of manufacturing goods and the share of manufacturing goods in total exports of goods reached 94 percent in 2006.

As a result of high increases in exports and imports, the share of Turkey in world trade has also increased. When the main export destinations of Turkey are analyzed, it is observed that Germany has always been the most important trading partner of Turkey, although its share in Turkey's total exports has been steadily declining. On the other hand, more than half of the exports of Turkey go to the EU countries. Figure 2.13 shows the share of exports to selected countries for the last two decades.

Figure 2.13: Main Export Destinations, % of Total Exports
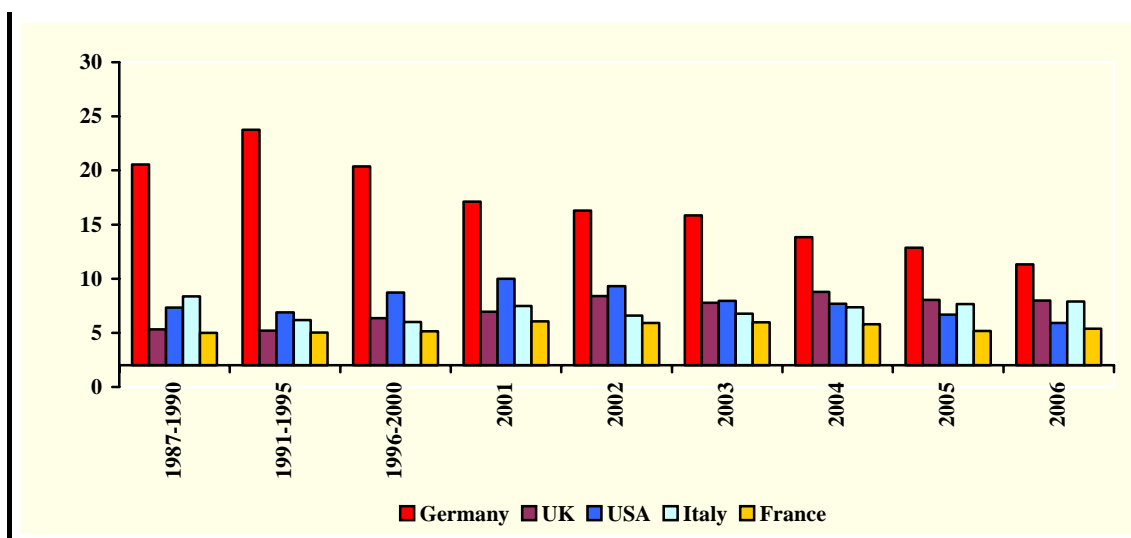
It is also noteworthy to mention that Turkey's efforts at increasing export market diversification to alleviate regional dependency in exports and to create sustainable export performance have been continuing (SPO, 2007). In recent years, Turkey has increased its exports to North America, Asia, Middle East, transition economies and Africa as a result of systematic advertising and marketing activities. For instance, in 2006 Turkish exports to North American countries and North African countries constituted 6.4 percent and 3.6 percent of total Turkish exports, respectively. Moreover, Turkey sold 13.2 percent of its exports to Near and Middle Eastern countries in the same year. On the other hand, while the number of countries that Turkey has an export value higher than 1 billion dollars was 14 in 2004, it reached 19 in 2006. In that sense, considering the fact that above the 65 percent of most of the EU-countries' export go to EU-25, it is evident that Turkey is different from an average EU-country in terms of the geographical diversification of its exports.

Figure 2.14: Main Import Origins, % of Total Imports
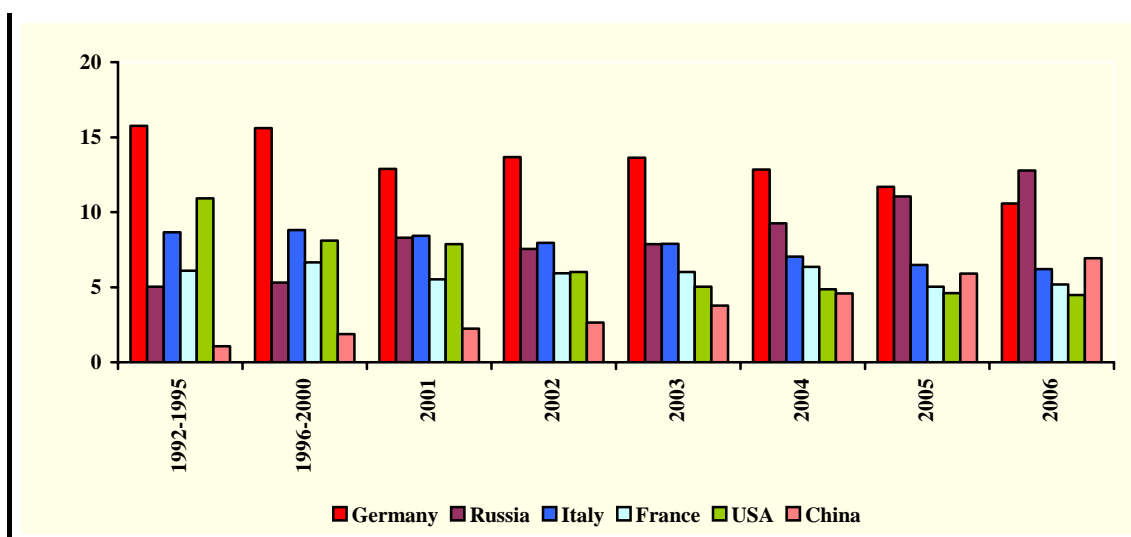
When the import origins of Turkey are examined, it is seen that most of Turkish imports come from EU countries. It is observed that, although the shares change over the years, Germany, France, and Italy continue to be important suppliers of imports to Turkey (Figure 2.14).

However, in recent years Russia and China have become important trading partners, and have increasing shares in Turkey's total imports. Especially in recent years China has become the leader among the emerging market economies in terms of competitiveness and its share in world trade has increased substantially. As it is the case for many other countries, the weight of China in Turkey's imports has increased remarkably. In 2006, China ranked as the third largest trading partner in terms of Turkey's imports. On the other hand, due to the fact that Turkey has a negligible amount of exports to China, China has become one of the countries with which Turkey runs a high trade deficit. With increasing energy demand and prices, the imports from Russia, and thus the weight of Russia in Turkey's imports, has increased considerably and in 2006 Russia ranked as the largest trading partner in terms of imports.

Figure 2.15: Net Trade Deficit[11] (Million Dollars) and the Ratio of Trade Deficit to GDP
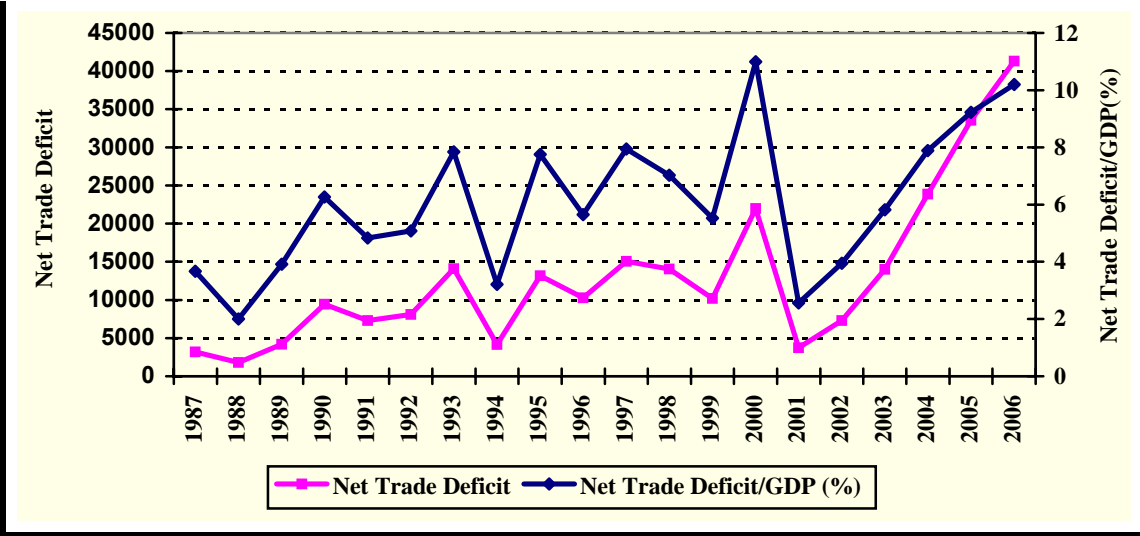
Source: TURKSTAT, CBRT

Figure 2.15 presents the net trade deficit in nominal terms (left axis) and the ratio of trade deficit to GDP of Turkey between 1987 and 2006 (right axis). As Turkey's production is highly dependent on imports, trade deficit has always increased substantially in high-growth years. It can be observed from the figure that especially after 2001 financial crisis, trade deficit have increased dramatically and reached 41 billion dollars as of 2006, which corresponds to 10.2 percent of GDP.

2.8 Public Sector Balances

Although fiscal discipline was not considered as one of the major macroeconomic policy objectives throughout the 1980s, the consolidated budget deficits were kept below 3 percent of GDP on average until 1988. However, starting from 1989 both the economic setting and the institutional environment started to change dramatically. First, real wages, which had been suppressed for almost a decade under the military rule and afterwards, could not be kept at their very low levels due to massive public protests and demonstrations of civil servants. Secondly, domestic financial liberalization created another source for deficit financing, namely domestic borrowing, which has played a determining role in terms of macroeconomic dynamics of the Turkish economy since 1990s.

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[11] Exports of goods less imports of goods

Given these new conditions, Turkey witnessed a drastic deterioration of its fiscal position after 1988. Initially the deterioration in fiscal balances was driven by the real wage increases in the public sector and some other public expenditure categories. Tax revenues did not rise sufficiently to offset the increases in expenditures. The deficit was mostly financed by domestic borrowing, which put upward pressure on the interest rates being faced by the Treasury. However, starting from 1994, Turkish economy plunged into a debt-interest vicious cycle and interest payments on the national debt became the main force causing further deterioration in the fiscal balances (Figure 2.16). Therefore, the government was trapped in Ponzi-financing in which interest payments could only be financed by issuing new debt (Akyüz and Boratav, 2003).

With increasing interest rates, the share of interest payments in GDP, which was 3.6 percent in 1989, exceeded 10 percent at the end of 1990s. The primary surpluses, which became a persistent characteristic of the budget since 1994, were not enough to reverse the upward trend in budget deficits until 2002. Therefore, budget deficits continued to rise considerably as a share of GDP, even though it could be kept under control in some years during this period. As a result, the ratio of budget deficit to GDP, which was 3.4 percent in 1989, increased to 11.5 percent in 1999 (Figure 2.16). Fiscal deficits basically caused by increasing interest payments put an upward pressure on the public debt stock. As a result, debt management became the focus of the macroeconomic management as of the end of 1990s.

After the 2001 crisis, fiscal discipline became one of the main pillars of macroeconomic management. The economic program focused on attaining high primary surpluses. Measures were taken to increase revenues and control public expenditures. With the establishment of confidence in the economy and favourable developments on macroeconomic fundamentals, interest rates and, consequently, the ratio of interest payments to GDP declined substantially. The ratio of interest payments to GDP, which reached 23 percent in 2001, decreased to 8 percent as of 2006. Consequently, the share of budget deficit in GDP, which was 16.5 percent in 2001, has declined substantially and was recorded as 0.1 percent in 2006.

Figure 2.16: Ratio of Consolidated Budget Deficit and Interest Payments to GDP (%)
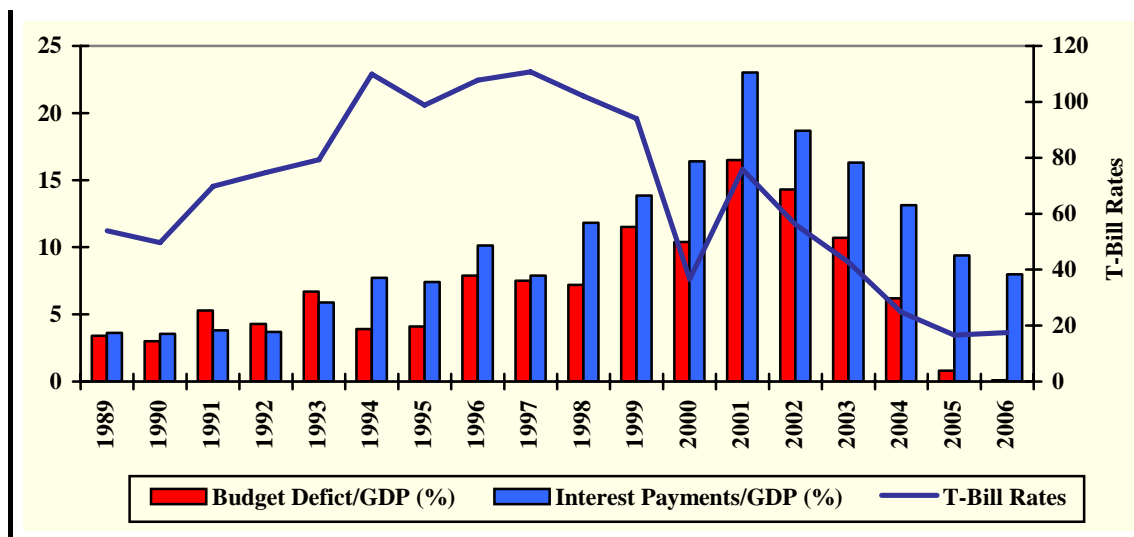
Source: SPO

When the fiscal position of Turkey as of 2006 is analyzed, it should be mentioned that remarkable progress has been achieved both in terms of restoring fiscal balances and reducing the debt burden of the economy. It can also be added that Turkey satisfied the Maastricht criteria in terms of its budget deficit and public debt stock to GDP ratio came very close to the criterion.

3. The Theoretical Structure of the HERMIN Model

3.1 Introduction

The new breed of macroeconomic models of the late 1980s addressed the theoretical deficiencies of conventional Keynesian econometric models that had precipitated the decline of modeling activity from the mid-1970s (Klein, 1983). 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), at least if conventional, reduced-form time-series models were used. In particular, the relationship between public investment policies and private sector supply-side responses - matters that were at the heart of policies like those of the EU Structural Funds - were not very well understood or articulated from a modeling 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 temporally, but was more suggestive of potential growth mechanisms than of actual magnitudes of growth to be expected in any specific country situation (Barro and Sala-i-Martin, 1995; Jones, 1998). Furthermore, the available empirical growth studies tended to be predominantly aggregate and cross-country rather than disaggregated and country-specific[12]. Yet another complication facing the designers and analysts of the early EU Structural Fund programmes 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 (e.g., distance from the developed agglomerations at the core of the EU). 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.

3.2 Approaches to Policy Modeling

The Keynesian demand-driven view of the world that dominated macro modeling 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-wracked 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 possible importance of the manner in which expectation formation was handled by modellers 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 original HERMIN model framework drew on some aspects of the above revision and renewal of macro economic modeling. The deep origins of the HERMIN model can be found 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

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[12] 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.

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)[13]. 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 modeling 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 difficult, if not impossible.

An example of a useful theoretical modeling framework is one that treats goods as being essentially internationally tradable (T) and non-tradable (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 that incorporates (and builds on) many of these theoretical insights, can be constructed.

3.3 One-and Two-sector Small-open-economy Frameworks

In the one-sector model all goods are assumed to be internationally tradable, 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

(3.1) $$p_t = e p_t^*$$

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 Ireland, Estonia or Slovenia, is that the assumption (implied by perfect competition) that domestic firms can sell all they desire to produce at going world prices is clearly 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 tradable-sector production in the small, open economy (SOE) is assumed to be carried out by internationally footloose multi-national corporations (MNCs) where price-setting decisions are independent of the SOE's

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[13] After German unification, the former East Germany was added to the list of "lagging" EU regions. The data difficulties in the new EU member states are even more severe. This reinforces the original decision to keep the HERMIN modeling framework as simple as possible.

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-tradable (N) sector, to the one sector model. Output and employment in the tradable sector (T) continues to be determined as before, while the non-tradable (N) sector operates more like a closed economy model. The interactions between the two sectors prove interesting however. For example, the price of non-tradables is determined by the interaction of supply and demand for these goods. This extension to two sectors (tradable and non-tradable) motivated the decision to identify the real world approximation of these sectors in the specification of the HERMIN model.

3.4 The Structure of a HERMIN Model

HERMIN 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 an 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 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 or current situation in the country, and the picture of the economy as captured in a HERMIN model calibrated with the use of historical data. In other words, calibration purely on the basis of econometrics using past data is likely to be inappropriate (even where it is feasible). Thus, while undertaking the calibration, the economy's existing situation should be evaluated with caution.

The HERMIN model framework focuses on key structural features of a cohesion-type economy, of which the following are important:

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 (internationally) traded sector), market services (a mainly non-traded sector that included building and construction), agriculture and government (or non-market) services (see Bradley, Herce and Modesto, 1995; Barry et al., 2003). In the present extension of the HERMIN framework, the aggregate market services sector (N) is disaggregated into two separate sub-sectors: building and construction (BC) and the rest of market services (N).[14] Although agriculture also has important traded elements, its underlying characteristics (e.g., price support under the CAP in the EU and its under-development in Turkey) imply that it requires 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[15].

The structure of the HERMIN modeling 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 the HERMIN modeling framework is described in terms of the above three blocks, which are schematically illustrated in Figure 3.1.

Conventional Keynesian mechanisms explain the short-term behaviour of the HERMIN model. When subjected to a demand shock, expenditure and income distribution sub-components generate many of the standard income-expenditure mechanisms. For example, the implementation phase of EU Structural Fund policy has a demand component, as long as public expenditure is actually increased, but longer-term supply side benefits have not yet appeared.

But the model also has many neoclassical features, both in the manufacturing sector and in the longer-term properties of the model. 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, market services and building and construction 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 (ON), 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), exports (X) and imports (M)). National income is determined on the output side, and disaggregated into private and public sector elements.

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[14] The separate treatment of building and construction (BC) is required since under some circumstances large proportion of the Structural Funds may involve investment in physical infrastructure.

[15] Elements of public policy are endogenous, but we prefer to handle these in terms of policy feed-back rules rather than behaviorally.

Since all elements of output are modelled, the output-expenditure identity is used to determine inventory stock changes residually to ensure that GDP on the output and expenditure sides are identical. 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.

3.5 The Supply Side of the HERMIN Model

3.5.1 Output Determination

The theory underlying the macroeconomic modeling 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 sub-sectors producing items that are effectively (or partially) non-traded. Hence, domestic demand is expected 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:

$$(3.2) \qquad \log(OT) = a_1 + a_2 \log(OWM) + a_3 \log(ULCT / POT)$$
$$+ a_4 \log(FDOT) + a_5 \log(POT / PWORLD) + a_6 t$$

where OWM represents the crucial external (or world) demand, and FDOT represents the influence of domestic absorption. OT is expected 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 (ON) is specified in HERMIN:

(3.3a) $\qquad \log(OBC) = a_1 + a_2 \log(IBCTOT) + a_3 \log(ULCBC/PCONS) + a_4 t$

(3.3b) $\qquad \log(ON) = b_1 + b_2 \log(FDON) + b_3 t$

where IBCTOT is total investment in building and construction by all the other four sectors and FDON is a measure of domestic demand. The variable ULCB is the unit labour costs in building and construction and is deflated by using the consumption deflator (PCONS).

Output in agriculture is modelled very simply as an inverted labour productivity equation;

(3.4) $\qquad\qquad\qquad \log(OA/LA) = a_0 + a_1 t$

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

Figure 3.1: The HERMIN Model Schema

Supply Aspects

Manufacturing Sector (mainly tradable goods)

Output $= f_1$(World Demand, Domestic Demand, Competitiveness, t)
Employment $= f_2$(Output, Relative Factor Price Ratio, t)
Investment $= f_3$(Output, Relative Factor Price Ratio, t)
Capital Stock $=$ Investment $+ (1-\delta)$ Capital Stock$_{t-1}$
Output Price $= f_4$(World Price * Exchange Rate, Unit Labour Costs)
Wage Rate $= f_5$(Output Price, Unemployment, Productivity)
Competitiveness $=$ National/World Output Prices

Building and Construction Sector (mainly non-tradable)

Output $= f_6$(Total Investment in Construction, t)
Employment $= f_7$(Output, Relative Factor Price Ratio, t)
Investment $= f_8$(Output, Relative Factor Price Ratio, t)
Capital Stock $=$ Investment $+ (1-\delta)$Capital Stock$_{t-1}$
Output Price $=$ Mark-Up On Unit Labour Costs
Wage Inflation $=$ Manufacturing Sector Wage Inflation

Market Service Sector (mainly non-tradable)

Output $= f_9$(Domestic Demand, t)
Employment $= f_{10}$(Output, Relative Factor Price Ratio, t)
Investment $= f_{11}$(Output, Relative Factor Price Ratio, t)
Capital Stock $=$ Investment $+ (1-\delta)$Capital Stock$_{t-1}$
Output Price $=$ Mark-Up On Unit Labour Costs
Wage Inflation $=$ Manufacturing Sector Wage Inflation

Agriculture and Non-Market Services: mainly exogenous and/or instrumental

Demographics and Labour Supply

Population Growth is exogenous
Labour Force $=$ Labour Force Participation Rate*Working Age Population
Unemployment $=$ Labour Force $-$ Total Employment

Demand (Absorption) Aspects

Consumption $= f_{12}$(Personal Disposable Income)
Exports $= f_{13}$(Manufacturing Output, Real Unit Labour Cost, t)
Imports $= f_{14}$(Final Demand, Ratio of Import Prices to Manufacturing Prices, t)
Domestic Demand $=$ Private and Public Consumption $+$ Investment $+$ Stock Changes
Final Demand $=$ Private and Public Consumption $+$ Investment $+$ Exports of Goods and Services
Stock Changes $=$ Gross Domestic Product (Output Approach) $-$(Private and Public Consumption $+$ Investment $+$ Exports of Goods and Services $-$ Imports of Goods and Services)

Income Distribution Aspects

Expenditure prices $= f_{15}$(Output prices, Import prices, Indirect tax rates))
Income $=$ Total Output
Personal Disposable Income $=$ Income $+$ Transfers $-$ Direct Taxes
Public Sector Borrowing $=$ Public Expenditure $-$ Public Revenue
Public Sector Debt $= (1 +$ Interest Rate $)$ Debt$_{t-1}$ $+$ Public Sector Borrowing

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Key Exogenous Variables
External: World output and prices; exchange rates; interest rates;
Domestic: Public expenditure; tax rates.

3.5.2 Factor Demands

Macro models usually feature production functions of the general form:

(3.5) $$Q = f(K, L)$$

where Q represents output, K capital stock and L employment. However, output is not necessarily actually determined by this relationship[16]. As mentioned above, 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 (i.e., OT, ON and OBC, as determined as in equations 3.2 and 3.3a and b in a hybrid supply-demand relationship), and given (exogenous) relative factor prices, the factor inputs, *L* and *K*, are determined via optimisation behaviour of firms by the production function constraint. Hence, the production function operates in the model as a <u>technology constraint</u> and is 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 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 experience of several small open economies (SOEs) suggests (Bradley *et al.*, 1995), this 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.[17]

Since the Cobb-Douglas production function is very restrictive, the CES form of the added value production function is used and imposed on the manufacturing (T), building and construction (BC) and market service (N) sectors. Thus, in the case of manufacturing;

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

In this equation, OT, LT and KT are added value, employment and the capital stock, respectively, *A* is a scale parameter, ρ is related to the constant elasticity of substitution, δ is a factor intensity parameter, and λ is the rate of Hicks neutral technical progress.

In both the manufacturing, market service and building and construction 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[18]:

(3.7a) $$K = g_1\left(Q, \frac{r}{w}\right)$$

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[16] In many models, capacity output is determined by the production function, with actual output determined in Keynesian fashion by demand. The ratio of actual to capacity output is usually taken as a measure of capacity utilization.

[17] Most models use the simple Cobb-Douglas production function, which is more tractable analytically. However, the imposition of a unit elasticity of substitution may seriously exaggerate the possibilities of factor substitution as relative factor prices change.

[18] See Bradley and Fanning (1984) for a full derivation of the factor demand system in the Cobb-Douglas and the CES cases.

$$(3.7b) \qquad\qquad L = g_2\left(Q, \frac{r}{w}\right)$$

where *w* and *r* are the cost of labour and capital, respectively[19].

Although the central factor demand systems in the manufacturing (T), building and construction (BC) and market services (N) 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 (OWM) 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, it is found that output (OBC and ON) is driven mainly by domestic demand (IBCTOT and FDON, respectively), with only a very limited possible role for world demand (OWM) in driving ON. This captures the essential difference between the neoclassical-like tradable sector and the sheltered Keynesian non-traded sector[20].

> (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 N), 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 modeling 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. As mentioned above, GDP in agriculture is modelled as an inverted productivity relationship (see above). Labour input into agriculture is 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.

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 and other policy criteria.

3.5.3 Sectoral Wage Determination

Modeling of the determination of wages and prices in HERMIN can be approached in many different ways. One might design equations that are specific to each sector, influenced by sectoral characteristics (e.g., degree of exposure to world competitiveness pressures, degree of unionisation, required level of human capital, etc.). However useful this approach is, it runs the risk of permitting wide divergences to emerge in sectoral wage inflation. Such divergences tend not to be observed in practice, at least over a medium-term horizon. Of course significant differences in the *level* of sectoral wages are observed, and these can persist over long periods.

Modeling of the determination of wages and prices in HERMIN is influenced by the so-called Scandinavian model (Lindbeck, 1979). Based on this model, the behaviour of the internationally exposed manufacturing (T) sector is assumed to be dominant in relation to

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[19] 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 original four EU cohesion countries. A hybrid putty-clay model is adopted in HERMIN (Bradley, Modesto and Sosvilla-Rivero, 1995).

[20] 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.

wage determination in the rest of the economy. The wage inflation determined in the manufacturing sector tends to be 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:

(3.8a)   WBCDOT = WTDOT + stochastic error

(3.8b)   WNDOT = WTDOT + stochastic error

(3.8c)   WADOT = WTDOT + stochastic error

(3.8d)   WGDOT = WTDOT + stochastic error

where WTDOT, WBCDOT, WNDOT, WADOT and WGDOT are the wage inflation rates in manufacturing, building and construction, market services, agriculture and non-market services, respectively[21].

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), 1991):

   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. Research suggests that it has at most a transitory impact (LNJ, 1991).

   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[22]:

(3.9) Log(WT) = a1+ a2 log(POT)+ a3 log(WEDGE) + a4 log(URBAR) +a5 log(LPRT)

where WT represents the wage rate, POT the price of manufactured goods, WEDGE the tax wedge, URBAR the moving average rate of unemployment and LPRT labour productivity.

3.5.4 Demographics and Labour Supply

The evolution of population tends to be fairly stable, in the absence of large migration flows. In the Turkish HERMIN model case, population is treated as exogenous and projected using external information.

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[21] Equations 3.8(a)-(d) are actually behavioural, in the sense that they state a testable hypothesis. Examination of data series for the period 1987-2006 suggests that they do capture trend behaviour (i.e., differences are fairly random, and a unit coefficient on WTDOT is plausible).

[22] In the Turkish HERMIN model, the coefficient of the tax wedge was found to be insignificant in the manufacturing wage equation, and was excluded from the equation. In any case, the effect is known to be zero in the long run (Layard, Nickell and Jackman, 1991).

In contrast to other countries, in Turkey data on working age population which, is officially published, cover not only 15-64 age group but also the age group above 64. Thus, working age population definition in Turkey differs from the generally accepted definition.

The labour force participation rate (i.e., LFPR, or the fraction of the working-age population (NWORK) that participates in the labour force (LF)), is treated as a single aggregate[23]. The aggregate labour force participation rate (LFPR) 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, together with the possibility of an encouraged/discouraged worker effect, proxied by the unemployment rate (UR). However, in Turkish HERMIN model it is found to be more appropriate to model the labour force participation rate as a time trend.

(3.10) $LFPR = a_1 + a_2 t$

3.6 Absorption in HERMIN

Household consumption represents the largest component of aggregate demand in most 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 by real personal disposable income (YRPERD). In other words, it is assumed that consumers are fully liquidity constrained.

(3.11) $CONS = a_1 + a_2 YRPERD$

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 four of the HERMIN five sectors as the investment part of the sectoral factor demand systems. Public investment is a policy instrument.

There is a major difference between the Turkish HERMIN model and other – mainly EU – HERMIN models, In other HERMIN models, the net trade surplus is determined residually in the output/expenditure identity. In the Turkish model, inventory stock changes are residually determined from the balance between GDP on an output basis (GDPM) and GDP on an expenditure basis (GDPE). Thus, imports and exports are explicitly modelled in the Turkish model.

A simple total import demand equation can be specified, where total imports (M) are determined by final demand (FD), a relative price term (PM/POT), and a time trend (T).

(3.12) $\log(M) = a_1 + a_2 \log(FD) + a_3 \log(PM/POT) + a_4 t$

A simple total export demand equation can also be specified, where total exports (X) are determined by manufacturing output (OT), real unit labour costs (ULCT/POT), and a time trend (T). Instead of world import demand, manufacturing output is used as an explanatory variable in the export equation under the assumption that Turkey is a small open economy which does not face demand constraint in export markets and that exports are constrained on the supply side.

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[23] Future versions of the HERMIN model might disaggregate employment by gender, in which case a similar disaggregation of the labour force would be required.

(3.13) $\log(X) = a_1 + a_2 \log(OT) + a_3 \log(ULCT/POT) + a_4 t$

Finally, stock changes (DS) are not modelled explicitly but modelled as a residual from the GDP identities for output (GDPM) and expenditure (GDPE).

(3.14) $DS = GDPM - (CONS+G+I+X-M)$

3.7 National Income in HERMIN

3.7.1 The Public Sector

With a view to its use for policy analysis, HERMIN includes a high degree of institutional detail in the public sector. Total public expenditure is disaggregated into 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, it would be ideal 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. But this refinement is left to later versions.

3.7.2 The National Income Identities[24]

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:

(3.15) $YC = NDPFCV-YW$

where YC is profits, NDPFCV is net national product 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:

(3.16) $YP = NDPFCV + GTR$

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

(3.17) $YPER = YP - YCU$

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

(3.18) $YPERD = YPER-(GTYP+GTYSOCW)$

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[24] In the following equations, we use simplified formulations. The actual model equations often include some additional terms (see Appendix 1).

where GTYP represents revenue from taxes on personal income by the household sector, GTYSOCW represents revenue from total social insurance contributions by employees. It is the constant price version of YPERD (i.e., YRPERD=YPERD/PCONS) which drives private consumption in the consumption function:

(3.19)   CONS = a_1 + a_2 YRPERD

3.8 The Monetary Sector

3.8.1 Introductory Remarks

In this version of the new HTR5 model, the monetary mechanisms are handled exogenously. This mechanism can be revisited in the next version of the model, since the goal of the HERMIN model is to attempt to capture realistic interactions between monetary, fiscal and cohesion policies. Ideally, it would be useful not only to study the impacts of public investment policies on monetary variables, but also to take account of any additional channels through which public policies may affect fluctuations in private sector activity (e.g. 'crowding out' effects)[25]. The discussion below illustrates our thinking on these issues.

Unlike the public investment and fiscal policies that operate under very similar principles in most countries and can therefore modelled within a general common framework, monetary policy regimes can differ between the countries in the cohesion group, with implications for the design of the monetary sector of the specific HERMIN country models. In particular, the group of EU cohesion countries for which HERMIN models have already been developed includes:

a)   Countries that are inside the euro zone (Ireland, Greece, Spain, Portugal, and (more recently) Slovenia);

b)   Countries with a fixed exchange rate (e.g. Bulgaria. Estonia, Latvia);

c)   Countries with full-fledged inflation targeting (IT), (e.g. Czech Republic, Poland); and

d)   Countries with intermediate regimes (e.g. Hungary[26], Slovakia and Romania).

Although there will be a tendency for these monetary regimes to converge, as the countries approach EMU membership, there may be a case for modeling this diversity, not only because the process is not likely to be fully completed by 2013, but also because countries can switch from one regime to another in the meantime (e.g. while Romania has most recently joined the IT group; other IT countries may soon embrace a combination of IT and an exchange rate band under the ERM II mechanism).

Adding a monetary sector into the country model framework would ideally satisfy the following criteria:

(i)   Provide for endogenous modeling of nominal interest and exchange rates, and money aggregates, and linkages to their real counterparts;

(ii)   Provide for monetary transmission mechanism of monetary policy variables (nominal interest/exchange rates) into real variables of the model in the short term, while ensuring monetary neutrality of these variables in the long term.

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[25] In the previous versions of the HERMIN model, crowding out takes place through labour market tightening (captured in the Philips curve) and through loss of international competitiveness.

[26] Hungary is an inflation targeting country that simultaneously announces an (relatively wide) exchange rate corridor.

(iii)   Provide for flexibility in handling various exchange rate regimes: fixed exchange rate and inflation targeting (including, e.g. intermediate cases of an exchange rate band).

Although monetary policy models often have a large number of equations and can be fairly complicated, designing a monetary sector embodying the essential principles of monetary policy in the small open economies of the group of cohesion countries can be based on interactions of a very small number of key variables, such as nominal and real interest rates, nominal and real exchange rates, output, some measure of producer marginal costs, and inflation. In fact, the models employed in several central banks of the country group are essentially models of these variables only, and ignore the wider macro-structural features of the economy, which are the principal purpose of HERMIN.

The monetary sector evolves along a 'canonical' model of monetary policy transmission embodied in these monetary policy models. Such a model involves three main channels through which the inflation stabilizes after a shock. A fast channel, that goes via nominal exchange rate and imported inflation which both respond to policy relatively rapidly in a small open economy. Two slower channels involve a reaction of demand versus supply (output gap) to monetary policy stimulus. In one of them, policy rates affect output through real interest rates, in the other through their effect on nominal and real exchange rate. Finally, stabilizing inflation has to consider the effects the shocks have on inflation expectations.

The role of policy variables (nominal interest and exchange rates) in this transmission mechanism scheme differs according to the policy regime in place. In inflation targeting, monetary policy acts as a key cyclical stabilizer in the economy by changing nominal interest rates in response to shocks threatening a serious deviation from the declared inflation target; in fixed exchange rate regimes, the economy stabilizes through an effect of real exchange rate on output, and nominal monetary variables are not directly involved in enacting the macroeconomic stabilization – which is in hands of fiscal policies.

3.8.2 Types of Monetary Transmission Mechanisms

Fixed Exchange Rate Regime:

As the original HERMIN country models were developed for the situation of quasi-fixed exchange rate regimes under the ERM mechanism, they already exhibit the relevant transmission channels, and modeling of the monetary sector is relatively straightforward. It consists primarily in linking movements in nominal and real interest rates to those of the world economy[27].

The standard HERMIN framework captures the direct pass-through of nominal exchange rate into prices and wages, and also the indirect effects operating through competitiveness impacts of real exchange rate (relative price of tradable goods) and real unit labour costs on output. In addition, the framework captures the effects of changes in real interest rates on output and inflation through capital formation and labour/investment decisions of firms. Both nominal exchange rate and real interest rate are therefore important exogenous policy variables of the original model framework, though disjoint.

The real interest rate can be endogenised by introducing market nominal interest rates that will move according to:

i)   the laws of international arbitrage in response to movements in the world interest rates (provided by international model systems such as the IMF *MULTIMOD* or the EU *QUEST*) and exogenous country risk premium, and

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[27] At present, this link can be established exogenously, since the direction of causality is from the world economy to the recipient economy, with little or no chance of reverse causation.

ii)   the extent of the sterilization policies/reserve accumulations that the country authorities decide to undertake. In this framework, international reserve targets can also be implemented as a target policy variable, if relevant for a particular country.

In addition, the block of monetary aggregates could be linked to the existing equations and variables (notably, consumption, output and interest rates), building on well established concepts. However, such a sophisticated approach may distract from the core function of HERMIN, without necessarily adding much by way of robust analysis that could not be included in off-model adjustment of the (exogenous) interest and exchange rates. A simpler approach is probably more desirable.

Flexible Exchange Rate and Inflation Targeting:

The monetary sector would need to become even more elaborate for the flexible exchange rate, inflation targeting countries. Here the policy variable will be market interest rate responding to deviations of inflation from targets (a Taylor-type policy rule), and the nominal exchange rate will become endogenous responding to differentials between domestic and foreign nominal interest rates (provided by international/global models) and exogenous country risk premia.

Hybrid Regimes:

For regimes that will exhibit both inflation targeting through changing market interest rates and a large degree of exchange rate management, the monetary sector will be a combination of the previous two extremes. As a convenient shortcut, the interest rate sensitivity of exchange rates can be limited, assuming the (explicit or implicit) exchange rate band is maintained through intra-marginal interventions[28]. By changing the sensitivity parameter it would be possible to allow for wider or narrower exchange rate bands and the final aim would be to parameterize (country specifics permitting) the choice of the exchange rate regime in the sense that the previous cases of pure inflation targeting or fixed exchange rate will result as special cases.

3.8.3 Monetary experiments and monetary neutrality

Operating the monetary sector and monetary policy in particular will differ according to the nature of policy experiments being carried out. In impact evaluations of cohesion policies, the effects of the policy measures need to be studied over an extended period of time that well exceeds the conventional horizon of monetary fluctuations and the control horizon of monetary stabilization policies. In such applications, the basic question of interest with respect to the monetary sector will be to what extent the planned measures will constrain medium term trajectories of nominal and monetary policy variables, and the other way round. In other application, though, shorter-term fluctuations of nominal variables as well as monetary policy effects will be important, especially for instance as regards studying 'crowding out' options during initial cohesion policy implementation, i.e., the period during which the economy is subjected to a positive demand shock, but before the supply-side benefits from the output and productivity spillovers come through.

The HERMIN framework was constructed with medium-term applications in mind, which is also reflected in its operating on an annual database. Given in addition the rudimentary nature of the original framework monetary block, it can be argued that the model simulation can be thought of as providing medium-term trajectories of real variables (e.g. real exchange

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[28] The width of the band as a probability density is then related to the sensitivity parameter and the structure of shocks hitting the economy. For a given shock structure, then, it can be parameterized using the sensitivity parameter.

rate) independent of monetary fluctuations. Models of monetary policy fluctuations run typically on data with higher frequency and although the fluctuations usually span over several years, most actions in small open economies typically take place within at most six quarters.

Investigating medium term trajectories of monetary sector variables will therefore be reasonably straightforward. In fixed exchange rate regimes, they will result from simple model simulations; in inflation targeting, on the other hand, the trajectory of nominal exchange rate will be inferred by imposing the inflation target on the actual inflation profile, while other variables (e.g. real exchange and interest rates) will be determined through the simulation[29]. A similar strategy has already been used in the context of HERMIN models when studying the development options of the Czech economy in Barry et al (2003).

When interactions with shorter term monetary policy are of interest, care will be taken to ensure neutrality of monetary policy actions in the longer term[30]. For that purpose, the policy experiment can be realized through a sequence of simulations:

(i)   First, a baseline simulation can be run using the assumption for the exogenous trends (i.e. mainly the inflation target) that would help determine baseline trajectories of trends for real interest and exchange rates.

(ii)   Second, the policy application in question can be studied using a simulation with the trend of real exchange and interest rates from the baseline simulation, where the actual levels of real exchange and interest rates will differ from the trends in the short-term.

These ideas are usually incorporated into macro models via a simple inflation targeting rule to endogenise interest rates, where the short-term nominal interest rate adjusts in response to changes in expected inflation, movements in the inflation rate and the output gap.

$$rs_t = rr_t^* + \pi_t^e + \mu(\pi_t - \pi_t^*) + v(y_t - y_t^*)$$

where

rs_t = short-term interest rate
rr_t^* = baseline value for real interest rate
π_t^e = expected inflation rate
π_t = inflation rate
π_t^* = baseline value of inflation rate
y_t = output gap
y_t^* = baseline value of output gap.

A special case would be the well-known Taylor rule, which might take the form

$$(rst - \pi_t) = 0.5 (\pi_t - \pi_t^*) + 0.5 y_t$$

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[29] The rate of change in the nominal exchange rate in the medium-term corresponds to the rate of inflation in small open economies.
[30] Such applications most likely arise in the context of active monetary policy making, i.e. Inflation Targeting regimes.

4. Calibration of the Behavioural Equations

4.1 Introductory Remarks

A country HERMIN model consists of a system of non-linear equations, where the number of equations is equal to the number of endogenous variables in the model. The equations are of two types: behavioural and identity. The behavioural equations are derived from theory. The identities are simply adding-up or definitional relations.

Only the behavioural equations contain parameters, whose values are not pre-determined by theory. The usual way to obtain estimates of these parameters is to use econometric techniques, applied to times series of all the variables (endogenous and exogenous) that are contained in any given equation. For small models, it is sometimes possible to apply econometrics to the model as a whole. Realistically, even when plenty of data points are available, for large-scale models one must use single-equation econometric techniques and try to control for the various types of bias that this generates.

Having outlined all the behavioural equations in Chapter 2, in this chapter the calibration results are presented. In view of the changing economic environment and rapid structural change, it was essential to use very simple calibration techniques.

Before proceeding with the analysis of the individual equations, a few qualifying remarks concerning the approach to calibration are appropriate.

There are 20 behavioural equations that have to be calibrated in each of the HERMIN country models, as follows:

- GDP arising in manufacturing (OT)
- 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 market services (ON)
- Factor demand system in market services(employment (LLN) and investment (IN)
- The GDP deflator for market services (PON)

- GDP arising in building & construction (OBC)
- Factor demand system in building & construction (employment (LBC) and investment (IBC)
- The GDP deflator for building and construction (POBC)

- 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)

- Labour force participation rate (LFPR)

- Household consumption (CONS)
- Total Exports (X)
- Total Imports (M)

- Deflator of total investment (PIAGG)
- Deflator of private consumption (PCONS))
- Deflator of total exports (PX)

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.

The OLS-based calibration (or curve fitting) technique 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. The use of dummy variables is avoided. In particular, structures such as the CES production function are imposed to make calibration easier. There is an obvious loss in modeling 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.

4.2 Calibration Results for Behavioural Equations

4.2.1 The Manufacturing Sector

In manufacturing output some parameter imposition was undertaken. The summation of elasticity with respect to world demand (OWM) and weighted final demand (FDOT) is imposed to be unity. In addition, the coefficients of real unit labour cost and competitiveness are imposed as -0.25. These latter are difficult to estimate at the level of aggregate manufacturing GDP (i.e., for OT). Only when one goes to a level of disaggregated output (e.g., NACE 2 or 3 digits) can one extract estimated elasticities that are meaningful (Carlin and Van Reenan, 2001).

The results are presented below in Table 4.1, and suggest that Turkish manufacturing output is more sensitive to domestic demand (FDOT) than to world (external) demand (OWM). Note the small, positive time trend (0.6 percent per year).

Table 4.1

$Log(OT) = a_1 + a_2*Log(OWM) + a_3*Log(ULCT/POT) + a_4*Log(FDOT) + a_5*Log(POT/PWORLD) + a_6*T$

a_1	a_2	a_3	a_4	a_5	a_6
3.73174	0.32531	-0.25	0.67468	-0.25	0.00642

Table 4.2 presents the calibration of the joint factor demand system for manufacturing. Since a CES production function is imposed, the underlying CES parameters are recovered, as shown in equation 3.6 in Chapter 3.

Although in some cases it is possible to recover plausible values for the elasticity of substitution (SIGT), it was decided to impose a value of 0.5, i.e., mid-way between a Cobb-Douglas value of unity and a Leontief value of zero. The remaining three parameters were calibrated from the data (using a highly non-linear approach implemented with TSP batch files: see Appendix 4.1 for details).

Table 4.2

CES Production function parameters - T-sector

AT	SIGT	LAMT	DELT
5.44091	0.5	0.01921	0.78423

The calibration suggests that the rate of Hicks-neutral technical progress is 1.9 percent per year, a value at the low end of the scale when compared with values obtained from the new EU member states. The Turkish rate is similar to the Portuguese, Greek and Spanish rate (see Bradley and Untiedt, 2008), but considerably lower than the values found in most of the new EU member states, which joined in 2004 and 2007.

The simple specification of the equation determining the deflator of manufacturing GDP (POT) seeks the balance between price taking behaviour (PWORLD) and a mark-up on unit labour costs (ULCT). Once again, free calibration, using different data samples, gave a wide range of results. But due to extreme multicolinearity between PWORLD and ULCT, these values are considered to be unreliable. Therefore, the summation of elasticity with respect to world price (PWORLD) and unit labour cost (ULCT) was imposed to be unity (i.e., price homogeneity is imposed). Given the high degree of openness of the Turkish economy (measured, say, by the ratio of exports and imports to GDP), Turkey can be considered as a small open economy, and the price in manufacturing sector (tradable sector) is assumed to be determined mostly by world prices. Hence, the elasticity of POT with respect to PWORLD is imposed as 0.7. Since homogeneity is imposed, the elasticity of POT with respect to ULCT is 0.3.

Table 4.3

Log(POT) = a1 + a2*Log(PWORLD) + (1-a2)*Log(ULCT)

a1	a2
5.09887	0.7

The fourth and last behavioural equation in the manufacturing sector determines the wage rate (or, more accurately, average annual earnings), WT. The theoretical derivation was explained in Chapter 2. The price deflator of manufacturing output, POT, is the main determinant of earnings, and full indexation of WT to POT is assumed. This is a reasonable assumption in the medium term, although it may not hold exactly in the short term. Experimentation also suggested that the rate of unemployment (URBAR, a two-year moving average of UR) was not very influential in wage bargaining, although negative effects were usually found. Rather than introduce spurious heterogeneity into the wage equation, a low Philips curve coefficient of -0.01 was imposed.

It also proved difficult to estimate the rate at which productivity changes fed into wages (a_3, the coefficient on LPRT. Over the period 1987-2006, labour's share of added value oscillated between 22 percent and 32 percent. This suggests that the ability of workers to use productivity increases to increase their wages, rather than to feed into profits, has varied over the data sample. For simplicity, a unit elasticity was imposed, i.e., all productivity gains feed into wages in the medium term.

Table 4.4

Log(WT/PCONS) = a1 +a2*URBAR+ a3*Log(LPRT)

a1	a2	a3
-1.30295	-0.01	1.0

4.2.2 The Market Services Sector

Only three behavioural equations are involved in this sector, since the wage equation is determined by pass-through of inflationary trends from manufacturing (the so-called Scandinavian model, see Lindbeck, 1979). The equation specification was described in Chapter 2. This sector is treated as a predominantly non-traded sector (since only a small fraction of market services are usually internationally tradable (e.g., tourism, banking, shipping, etc.).

Turning first to market services output (ON), the effect from domestic demand was found to be strong, and the size of the coefficient a_2 plays a major role in determining the magnitude of the Keynesian multiplier. Note the strong, autonomous time trend (almost 2.8 percent per year).

Table 4.5

Log(ON) = a1 + a2*Log(FDON) + a3*T

a1	a2	a3
5.03145	0.47282	0.02756

The CES production function was also used in the market services sector. In contrast to the CES production function in manufacturing sector, a uniform value of 0.5 for the elasticity of substitution in market services sector was not imposed, and the value 0.589 was freely estimated. Note that the rate of Hicks-neutral technical progress was found to be less than 0.2 percent, i.e., almost zero.

Table 4.6

CES Production function parameters - N-sector

AN	SIGN	LAMN	DELN
9.00056	0.58867	0.0019795	0.90225

The last behavioural equation in market services determines the output deflator (PON) as a mark-up on unit labour costs (ULCN) and its lagged value (ULCN(-1)). The summation of elasticities with respect to unit labour cost and its lag value was imposed to be unity.

Table 4.7

Log(PON) = a1 + a2*Log(ULCN) + (1-a2)*Log(ULCN(-1)

a1	a2
1.97307	0.60517

4.2.3 The Building and Construction Sector

Although the output equation determining OBC was described as "behavioural", it is, in effect, a quasi identity, related to an underlying input-output relationship. Total investment in building and construction activities (IBCTOT, determined within the model as investment by type of good) is linked to output of the building sector (OBC), with the possibility of a real unit labour cost effect as well (RULCB).

It is noticed that in many countries the ratio of OBC to IBCTOT declined steadily over time, so it is allowed for this effect in the Turkish equation specification by adding a time trend. The parameters are shown in Table 4.8.

Table 4.8

Log(OBC) = a1 + a2+Log(IBCTOT) + a3*T

a1	a2	a3
3.52935	0.536202	-0.000241540

The CES production function was also used in the building and construction sector. A value of 0.8 for the elasticity of substitution was imposed since it proved difficult to calibrate from the data. This value is at the Cobb-Douglas end of the [0 < SIGBC < 1] spectrum. Note the small value of the Hicks-neutral technical progress term (0.6 percent per year).

Table 4.9

CES Production function parameters - BC-sector

ABC	SIGBC	LAMBC	DELBC
3.43202	0.80	0.0060048	0.76113

The last behavioural equation in the building sector determines the output deflator (POBC) as a mark-up on unit labour costs (ULCBC). Some lagged effects were found.

Table 4.10

Log(POBC) = a1 + a2*Log(ULCBC) + (1-a2)*Log(ULCBC(-1))

a1	a2
0.85703	0.84637

4.2.4 The Agricultural Sector

There are three simple behavioural-type equations in this sector. The first determines trend labour productivity. The second determines trend labour-release. And the third determines trend capital/labour ratio. The findings are summarised in Tables 4.11, 4.12 and 4.13.

The findings are as one might expect. For example, trend labour productivity in agriculture is growing over time at a rate of nearly 5 percent per year (Table 4.11).

Table 4.11

Log(OA/LA) = a1 + a2*T

a1	a2
-0.02614	0.04871

Table 4.12 shows that agricultural employment is declining in Turkey. The rate of decline is approximately 4 percent per year.

Table 4.12

Log(LA) = a1 + a2*T

a1	a2
9.55801	-0.03972

Table 4.13 presents the calibration results for the capital/labour ratio. Here, the capital/output ratio is growing at a rate of almost 3.4 percent per year.

Table 4.13

Log (KA/OA) = a1 + a2*T

a1	a2
-0.05049	0.03373

4.2.5 Demographics and Labour Supply

This part of the model contains one behavioural equation that determines the labour force participation rate. The other variables like population by three age cohorts were set as exogenous, and can be projected outside the model system.

Table 4.14 shows the results of calibrating the labour force participation rate (LFPR). LFPR is modelled as a time trend. In other words, variations in unemployment rates did not seem to shift the participation rates much. In practice, LFPR was usually trended, with only very minor fluctuations. Consequently, the coefficient on unemployment was set at zero and only the time trend was included.

Table 4.14

LFPR = a1 + a2*T

a1	a2
59.0258	-0.57935

The participation rate has been trending downwards between 1987 and 2006 (at almost 0.6 percentage points per year).

4.2.6 Expenditure

This part of the model contains three behavioural equations that determine the private consumption, total exports and total imports.

The calibration results for the consumption function are shown in Table 4.15. The specification is the simple liquidity constrained "Keynesian" function, where the only determinant of consumption (CONS) is real personal disposable income (YRPERD).

The most important parameter insofar as the Keynesian multiplier is concerned is the so-called "marginal propensity to consume" (or MPC). Its estimated value (0.847) lies in the plausible range.

Table 4.15

CONS = a1 + a2*YRPERD

a1	a2
-915.631	0.84683

Total import demand is determined by final demand (FD), a relative price term (PM/POT), and a time trend (T). When freely estimated, and in the absence of any time trend, the coefficient on FD is much greater than unity. However such results are discounted in the modeling literature as being implausible. The coefficient of final demand was set as 1. The findings are reported in Table 4.16. Note the time trend of 4.7 percent per year, and the modestly negative competitiveness elasticity of -0.25.

Table 4.16

M = a1 + a2*FD + a3*(PM/POT) + a4* T

a1	a2	a3	a4
-2.00224	1.0	-0.25262	0.04744

For the export demand equation calibration results are presented in Table 4.17. Total exports are determined by manufacturing output (OT), real unit labour costs (ULCT/POT), and a time trend (T). For the same reasons as discussed in the import equation, the coefficient of manufacturing output in export equation was imposed as 1. An increase in manufacturing output is fully reflected in total exports. Note the high time trend of 5.5 percent per year, and the modest price competitiveness elasticity of 0.29.

Table 4.17

X = a1 + a2*OT + a2*(ULCT/POT) + a4* T

a1	a2	a3	a4
-0.92348	1.0	-0.29284	0.05495

4.2.7 Expenditure Deflators

The final three behavioural equations determine the price deflators for total investment (PIAGG), private consumption (PCONS) and total exports (PX).

Deflators for total investment and private consumption are functions of the prices of inputs to expenditure, namely the GDP deflator (PGDPFC) and the import price (PM). In both equations price homogeneity was imposed. The calibration results for investment and consumption deflators are shown in Table 4.18 and Table 4.19.

Table 4.18

Log(PIAGG) = a1 + a2*Log(PGDPFC) + (1-a2)*Log(PM)

(apply to: PIT, PIN, PIBC, PIA, PIG)

a1	a2
-0.11243	0.57414

In the case of the consumption deflator, an indirect tax term, RGTE, as a ratio of GDP is added and it is assumed that all indirect tax changes appear as price changes, i.e., tax changes are passed on to consumption prices.

Table 4.19

Log(PCONS) = a1 + a2*Log(PGDPFC) + (1-a2)*Log(PM) +a3*RGTE

a1	a2	a3
-0.076196	0.84743	1.0

In total exports deflator, the GDP deflator (PGDPFC) and the world price (PWORLD) were set as main determinants. Again price homogeneity was imposed. Considering Turkey as a small open economy and evaluating its price making power, a high elasticity on PWORLD (0.8) was imposed (Table 4.20).

Table 4.20

Log(PX) = a1 + a2*Log(PGDPFC) + (1-a2)*Log(PWORLD)

a1	a2
5.20704	0.2

5. Implementing and Testing the HERMIN Model

5.1 Introduction

In Chapter 4 the first stage of model testing was described, namely the calibration of the model. Further testing starts with the simulations that were designed to check the within-sample tracking performance. It should be 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 the model is subjected to further tests, and the performance of the system of equations is examined as a whole.

First the process of checking the model structure by 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) is described briefly. This process of "residual checking" is important to establish that the data and the model are internally consistent. Then, it is described how to prepare a baseline out-of-sample projection, starting with the last within sample year, 2006, and how to simulate the model to the year 2020. Finally, it is described how to subject the model to a standard series of exogenous and policy shocks in order to explore its responses.

5.2 Checking the Model Structure

Even though the model is primarily designed for policy oriented experiments and multiplier analyses, the within sample performance of the model is not neglected. A reasonable within sample tracking is not only 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 is used in the design stage of model construction, when it is often necessary to return back to the calibration stage when such a check produced unsatisfactory results.

The control of the within sample performance is carried out by means of a so-called residual check simulation. Once the individual behavioural equations have been calibrated, and the model as a parameterised system of equations is set up, a static simulation is undertaken and this simulation uses 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 is then compared to their actual historical values. More specifically, the percentage difference of the simulated from actual values is of interest.

There is no obvious benchmark as to what percentage difference constitutes a reasonable fit of an equation. Rather, it varies from case to case, but overall a difference below 10 percent for all of the most important behavioural variables is aimed. 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, these differences for each behavioural variable are expected to change signs over time, suggesting a random error. Unless this residual check produces satisfactory results, it is necessary to come back to calibration of the most troublesome equations and once more to review the whole process. In the end, most behavioural variables ended up showing less than 5 percent difference from the historical values in every year. The main exceptions were investment variables, IT, IN, IBC and IA, which are very difficult to track with a model of the highly constrained type that is used here. 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, it is desirable 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, a static within sample simulation is carried out as before, but this time each equation is solved independently and not as part of the simultaneous system. Then, the absolute difference between the simulated and true values is computed. These absolute differences create the so called constant adjustment (or CA) factors for each behavioural variable and within sample year of simulation. These adjustment factors are, effectively, corrections to the estimates of behavioural intercepts in each behavioural equation, with the property that they make the computed variable exactly fit the data. Therefore, if these constant adjustment factors are added back to each behavioural equation, a perfect fit of the whole model will be obtained within sample. What is more important, though, is that this information on the error can be used in the behavioural intercepts in the out of the sample projections and simulations, as will be shown below.

5.3 Projections: External and Policy Assumptions

Before proceeding with the policy shocks and experiments, it is necessary to set up a baseline scenario. The baseline scenario is an out-of sample simulation built on a particular development path of exogenous variables. The assumptions regarding exogenous variables were made on a judgemental basis. However, these projections can always be revisited and made more realistic using more sophisticated knowledge.

The preparation of the baseline scenario is, in fact, the very first stage in the process that leads eventually to a realistic medium-term forecast. For the purposes of out-of-sample projection, the external and policy variables can be grouped into five different types, as follows:

5.3.1 External (or world) Variables

There are about 20 variables in this important category in the Turkish HERMIN model.

   a) <u>World economic growth</u>: The rate of growth of total imports in Turkey's main trading partners (i.e., the main export destinations that include Germany, France, Italy, the United Kingdom, etc.) is in line with the realizations for 2007-2008 and consistent with EC forecasts for 2009-2010 period. For the period 2011-2020, it is assumed to be 5 percent per year considering the recovery expectations regarding the world economy.

   b) <u>External prices</u>: There is one set of external prices, the industrial prices of Turkey's main trading partners, to be projected. A common increase rate of 2 percent per year is assumed for the period 2007-2020.

5.3.2 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)   <u>Public employment (LG)</u>: Employment numbers are increased by 2 percent per year for 2007-2020.

b)   <u>Other elements of real public consumption (RGENW, OGNW)</u>: These variables are increased by 2 percent per year for 2007-2020.

c) Other elements of public expenditure (e.g., IGV): These variables are assumed to be in line with realizations and expectations for 2007-2010 period, while they are projected to grow in nominal terms by 6 percent per year for 2011-2020.

d) Tax rates: These variables are fixed at their 2006 values until 2020.

e) The exchange rates of the recipient country's currency against the currency of its main trading partners: These are projected as being fixed at their 2006 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 be determined endogenously.

All the precise values used for exogenous variables can be seen in Appendix A5.2.

5.3.3 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 2006 (end-of-sample) values.

b) Miscellaneous: Most remaining exogenous variables are projected as being fixed in real terms, *ex ante*. See Appendix A5.2 for the precise values used.

5.3.4 Modifications of Time Trends

A range of time trends has been used in the model and values were calibrated using within-sample data from 1987-2006. For 2007-2008, time trends were calibrated to reflect the realizations and provide a sound base for medium-term projections[31]. As for 2009 and 2010, time trends were set to capture the impacts of the global financial crisis on the Turkish economy and attain more realistic projections for the mentioned period.

On the other hand, for post-2011 period it is assumed that the effects of the global financial crisis will start to fade away for both the global economy as well as for Turkey. Therefore, the time trends were projected with some reflection on their characteristics for the medium term.

The following are the main kinds of assumptions made about the future path of the key time trends in the Turkish HERMIN model:

a) Hicks neutral technical progress: The calibrated values within-sample for manufacturing (T), building and construction (BC), and market services (N), are used initially. Out of sample, these can be modified. For example, if the calibrated rates are very low, it would be unwise to assume that technical progress would necessarily continue at this rate for a modernizing economy.

b) Agricultural productivity growth: The within-sample growth rate for 1996-2006 period is projected to decline, since agricultural employment is not expected to decline as sharply as before.

c) Agricultural employment: Employment has declined significantly since the second half of 1990's in Turkey. It was assumed that this high rate of decline in employment in agriculture would slow down in the forthcoming period.

d) The capital/output ratio in agriculture: The within-sample growth rate for 1996-2006 period is usually projected unchanged.

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[31] The data sample of Turkish Hermin model covers 1987-2006 period and national account figures are at 1987 constant prices. However, in 2008 national accounts data has been revised to 1998 constant prices for post-1998 period and national account figures were not announced at 1987 constant prices for the years 2007 and 2008. For this reason, time trends were calibrated to reflect known characteristics of 2007 and 2008 in the simulations.

e) <u>Labour force participation rate</u>: The within-sample annual changes (declines or increases) are usually set to zero out of sample.

f) <u>Trend sectoral output growth</u>: Where there are significant time trends in any sectoral output equations (positive or negative), these have to be projected with care. In order to maintain consistency with the output side of the model, the export and import time trends are projected accordingly.

All the precise values used for mentioned variables can be seen in Appendix A5.2.

5.3.5 Behavioural Intercept Adjustments

Usually, the simple assumption that the value of the 2006 within-sample error for the behavioural equations remains unchanged forward to 2020 is made. However, when a behavioural equation defines a rate of change or a flow (e.g., wage inflation in the N-sector (WNDOT), etc.), the error is projected as zero. Appendix A5.2 gives the precise values used.

5.4 The Baseline Projection for 2007-2020

The purpose of this section is to present some key features of the baseline projection prepared using the new HERMIN model, HTR5. Currently, the historical data sample extends from the year 1987 to the terminal year 2006. And the data sample cannot be updated to include the years 2007 and 2008, since TURKSTAT has not published the 2007 annual data at 1987 constant prices.

The exact assumptions made for the exogenous variables are contained in the WINSOLVE LOG file that is used to prepare projections, and is listed in Appendix 5.2. Since this is a paper on model construction and testing methodology, these assumptions are not described in any detail. Our purpose is to show how projections can be produced using the model. In the present case, the projections assume an adverse world growth scenario for 2009 and 2010 and a fair growth rate thereafter. The projections assume stable and low world inflation. It is also assumed that tax rates are kept fairly constant out of sample, at their 2006 values, and that public expenditure in mainly indexed, i.e., preserved in real terms. Certain technical adjustments are made to some of the time trends, in order to reflect how these are likely to change over the next ten years.

Table 5.1 presents growth rates of aggregate GDP (GDPFC), and the five sectoral components of GDP. The years 1996-2006 are highlighted to emphasise that these are the historical values of the growth rates, as contained in the database. The years 2007-2020 are produced using the model simulations.

The scenario suggests that aggregate GDP growth will be in the region of 3.4 to 4.8 percent per year in 2010-2020 period implying that Turkish economy will grow around its potential. Growth in manufacturing is the highest (in range 4.0 to 5.7 percent per year). Growth in market services and building and construction is lower. Growth in government output simply reflects the growth of 2 percent in public employment that was assumed. And growth in agriculture is lowest, at 1.6 percent per year, reflecting the exponential nature of the output equation (refer Section 4.2).

Table 5.1: Baseline projection of sectoral and total GDP

Year	GDPFC	OT	ON	OBC	OA	OG
1996	6.42	6.82	7.63	5.85	4.40	-0.29
1997	7.03	11.05	8.71	5.01	-2.34	0.09
1998	3.30	1.63	2.89	0.75	8.37	5.94
1999	-4.66	-5.77	-3.63	-12.51	-4.99	2.74
2000	6.35	5.99	7.94	4.40	3.86	1.99
2001	-6.47	-8.19	-6.36	-5.49	-6.51	1.60
2002	7.16	9.60	7.97	-5.59	6.87	0.73
2003	4.88	8.04	6.97	-8.98	-2.50	0.85
2004	7.84	9.78	9.12	4.65	2.02	1.16
2005	7.02	6.34	7.10	21.54	5.63	0.78
2006	5.87	7.27	4.91	19.41	2.90	1.98
2007	4.97	6.36	6.79	6.49	-5.77	2.00
2008	1.12	1.09	1.28	-6.43	3.80	2.00
2009	-4.08	-10.90	-1.87	-7.89	2.89	2.00
2010	3.41	3.97	3.60	4.06	1.53	2.00
2011	4.70	5.38	5.16	5.48	1.61	2.00
2012	4.76	5.73	5.19	4.10	1.61	2.00
2013	4.76	5.69	5.17	4.07	1.61	2.00
2014	4.77	5.67	5.17	4.07	1.61	2.00
2015	4.78	5.64	5.17	4.08	1.61	2.00
2016	4.79	5.62	5.17	4.09	1.61	2.00
2017	4.79	5.59	5.17	4.10	1.61	2.00
2018	4.80	5.57	5.17	4.11	1.61	2.00
2019	4.80	5.54	5.16	4.11	1.61	2.00
2020	4.80	5.51	5.15	4.12	1.61	2.00

Table 5.2 presents the growth rates of sectoral labour productivity for manufacturing, market services and building and construction sectors. These reflect the values of the rates of technical progress in the three production functions (refer Section 4.2), and the manner in which they were altered out of sample.

Table 5.2: Baseline projection of sectoral productivity growth

Year	LPROD	LPRT	LPRN	LPRBC	LPRA
1996	3.40	0.03	5.64	0.96	2.38
1997	6.99	4.79	4.05	3.26	2.33
1998	0.56	1.37	-1.68	0.44	5.96
1999	-5.84	-7.78	-8.17	-15.14	-3.04
2000	8.67	5.13	-8.19	4.55	18.39
2001	-6.22	-7.16	-4.92	16.05	-10.21
2002	8.02	4.71	4.16	9.38	15.92
2003	5.89	11.04	3.99	-9.64	1.47
2004	4.66	5.31	5.22	-1.77	-1.21
2005	5.78	-1.19	-1.03	6.52	20.35
2006	4.53	4.51	-0.37	10.55	9.76
2007	2.29	2.22	1.35	2.70	-4.18
2008	0.54	1.39	0.58	-0.75	2.08
2009	-0.90	2.40	0.92	0.77	1.19
2010	1.53	2.46	1.46	2.15	-0.15
2011	2.64	2.00	1.19	0.97	3.31
2012	2.65	2.01	1.19	1.06	3.32
2013	2.60	2.00	1.18	1.04	3.32
2014	2.56	2.00	1.18	1.04	3.32
2015	2.52	2.01	1.18	1.04	3.32
2016	2.49	2.01	1.17	1.04	3.33
2017	2.45	2.01	1.17	1.04	3.33
2018	2.41	2.01	1.16	1.04	3.33
2019	2.37	2.01	1.16	1.03	3.33
2020	2.34	2.01	1.16	1.03	3.34

Aggregate, economy-wide, productivity grows at between 2.3 and 2.7 percent per year for the 2010-2020 period. It is fastest in agriculture since there is a continuing shift from agriculture to non-agricultural sectors without any loss in agricultural output. Thus, this productivity increase basically arises from the hidden employment in agriculture. Productivity increases in manufacturing come next with an average at 2 percent, and it is lowest in building & construction with an average at about 1.0 percent per year. The value for manufacturing is very low when compared with the high rates being experienced in many of the new EU member states. For example, in the Baltic States, Poland, Slovakia, the Czech Republic, rates of almost 10 percent per year have been experienced in the recent past.

Table 5.3 presents projections for the labour force participation rate (LFPR) and the rate of unemployment. The notation "(I)" is used to indicate that these are levels, and not growth rates. In cases where there is no "(I)", the data are always growth rates.

It is seen that the model projection is one where the slow decline in the participation rate experienced in the recent past ceases, and for the simulation period labour force participation rate was kept as fixed. The rate of unemployment expressed as a percentage of the labour force and based on ILO definitions, peaks at 2009 and remains at above 10 percent until 2016 and declines to below 10 percent thereafter, reaching a value of 7.6 percent by 2020.

Table 5.3: Baseline projection of labour force participation rate (LFPR) and the rate of unemployment (UR)

Year	LFPR (I)	UR (I)
1996	53.73	6.63
1997	52.55	6.83
1998	52.79	6.87
1999	52.70	7.65
2000	49.94	6.49
2001	49.81	8.38
2002	49.58	10.35
2003	48.33	10.54
2004	48.67	10.29
2005	48.33	10.25
2006	47.95	9.87
2007	48.01	8.98
2008	48.13	10.03
2009	48.13	14.20
2010	48.13	13.90
2011	48.13	13.47
2012	48.13	13.00
2013	48.13	12.48
2014	48.13	11.92
2015	48.13	11.31
2016	48.13	10.66
2017	48.13	9.97
2018	48.13	9.23
2019	48.13	8.45
2020	48.13	7.63

Note: "(I)" refers levels of the variables.

Table 5.4 presents projections for employment, in total (L) as well as for the five HERMIN model sectors (manufacturing (LT), market services (LLN), building and construction (LBC), agriculture (LA) and government (LG).

The overall employment projections are quite optimistic, at an average of 2.2 percent from 2011 to 2020. This means that employment grows from its 2006 value of 22.3 millions to a value of 28.3 millions by 2020. In other words, employment numbers increase by about 6 millions, or by 600 thousands per year. Such growth depends mainly on the fact that output

is growing, but productivity is growing more slowly, particularly in the market services sector. If the Turkish economy modernised, the growth of productivity would be much higher, and employment growth much lower. Such scenarios – jobless growth – can easily be explored using the model.

Employment growth is seen to be spread fairly evenly across all sectors, in terms of growth rates. Only agriculture shows a decline in employment, as labour leaves low income farm work and seeks better employment prospects in the urban areas.

Table 5.4: Baseline projection of sectoral employment growth and levels

Year	L	L (I)	LT	LT (I)	LLN	LLN (I)	LBC	LBC (I)	LA	LA (I)	LG	LG (I)
1996	2.92	21192.0	6.79	3399.0	1.88	4480.1	4.85	1298	1.97	9259.0	2.36	2755.9
1997	0.04	21200.0	5.97	3602.0	4.47	4680.5	1.69	1320.0	-4.56	8837.0	0.17	2760.5
1998	2.73	21779.0	0.25	3611.0	4.65	4898.1	0.30	1324.0	2.27	9038.0	5.34	2907.9
1999	1.25	22051.0	2.19	3690.0	4.94	5140.2	3.10	1365.0	-2.01	8856.0	3.16	2999.8
2000	-2.13	21581.0	0.81	3720.0	17.56	6042.9	-0.15	1363.0	-12.27	7769.0	-10.46	2686.1
2001	-0.27	21523.0	-1.10	3679.0	-1.51	5951.5	-18.56	1110.0	4.12	8089.0	0.28	2693.5
2002	-0.79	21352.0	4.68	3851.0	3.65	6168.9	-13.69	958.0	-7.81	7457.0	8.30	2917.1
2003	-0.96	21148.0	-2.70	3747.0	2.86	6345.7	0.73	965.0	-3.92	7165.0	0.28	2925.3
2004	3.04	21790.0	4.24	3906.0	3.70	6580.5	6.53	1028.0	3.27	7399.0	-1.67	2876.5
2005	1.18	22047.0	7.63	4204.0	8.22	7121.1	14.11	1173.0	-12.23	6494.0	6.20	3054.9
2006	1.28	22330.0	2.64	4315.0	5.30	7498.9	8.01	1267.0	-6.25	6088.0	3.48	3161.2
2007	2.63	22916	4.05	4490	5.36	7901	3.69	1314	-1.66	5987	2.00	3224
2008	0.58	23049	-0.29	4477	0.70	7956	-5.72	1239	1.68	6088	2.00	3289
2009	-3.21	22310	-12.99	3895	-2.76	7737	-8.60	1132	1.68	6190	2.00	3355
2010	1.85	22722	1.47	3953	2.10	7900	1.87	1153	1.68	6295	2.00	3422
2011	2.01	23179	3.31	4083	3.93	8210	4.46	1205	-1.65	6190	2.00	3490
2012	2.06	23656	3.65	4232	3.95	8534	3.01	1241	-1.65	6088	2.00	3560
2013	2.10	24153	3.61	4385	3.94	8871	2.99	1278	-1.66	5987	2.00	3631
2014	2.15	24672	3.59	4543	3.95	9221	3.00	1317	-1.66	5888	2.00	3704
2015	2.20	25215	3.57	4705	3.95	9586	3.01	1356	-1.66	5790	2.00	3778
2016	2.24	25781	3.54	4871	3.95	9965	3.02	1397	-1.66	5694	2.00	3853
2017	2.29	26371	3.51	5042	3.96	10359	3.03	1440	-1.66	5599	2.00	3930
2018	2.33	26985	3.49	5218	3.96	10768	3.04	1483	-1.66	5506	2.00	4009
2019	2.37	27625	3.46	5399	3.95	11194	3.05	1529	-1.66	5415	2.00	4089
2020	2.41	28291	3.43	5584	3.95	11636	3.06	1575	-1.67	5324	2.00	4171

Note: The notation "(I)" is used to indicate that these are levels, and not growth rates. In cases where there is no "(I)", the data are always growth rates.

Table 5.5 presents the projections for growth of the main expenditure items of GDP: household consumption (CONS); total investment (I), government consumption (G), exports (X) and imports (M). It will be recalled that stock changes (DS) are used to reconcile GDP on an output basis and GDP on an expenditure basis.

The growth in exports and imports are higher than GDP growth, which shows that Turkey becomes increasingly integrated into the EU and wider world economies. Investment grows at a higher rate than household consumption and investment and consumption growth rates are 5.6 percent and 4.6 percent annually on average for 2011-2020 period, respectively. Only government consumption grows more slowly, at about 2.0 percent per year, and this is due to the assumptions made when projecting the policy instruments (see Appendix 5.2)

Table 5.5: Baseline projections of growth in the main expenditure components

Year	CONS	I	G	X	M
1996	8.49	14.07	8.58	21.96	20.52
1997	8.39	14.84	4.12	19.12	22.44
1998	0.63	-3.90	7.85	12.00	2.33
1999	-2.61	-15.68	6.49	-7.04	-3.66
2000	6.17	16.89	7.14	19.18	25.40
2001	-9.18	-31.54	-8.54	7.40	-24.84
2002	2.10	-1.10	5.40	11.14	15.83
2003	6.63	9.99	-2.44	15.98	27.06
2004	10.06	32.36	0.53	12.47	24.69
2005	8.76	24.02	2.43	8.52	11.52
2006	5.22	13.99	9.61	8.49	7.11
2007	4.25	5.13	2.00	6.60	8.59
2008	1.86	0.72	2.00	4.19	-3.65
2009	-1.35	-6.07	2.00	-10.77	-15.03
2010	3.07	6.12	2.00	6.70	7.51
2011	4.46	5.72	2.00	5.62	6.30
2012	4.62	5.58	2.00	5.94	6.45
2013	4.61	5.50	2.00	5.87	6.39
2014	4.61	5.52	2.00	5.81	6.37
2015	4.60	5.54	2.00	5.76	6.34
2016	4.59	5.56	2.00	5.70	6.31
2017	4.58	5.58	2.00	5.65	6.28
2018	4.56	5.60	2.00	5.59	6.25
2019	4.53	5.61	2.00	5.54	6.22
2020	4.51	5.62	2.00	5.48	6.19

Table 5.6 shows the inflationary environment of the projection, based, of course, on the assumptions that have been made about the global inflationary environment. The rate of wage inflation (between 3.9 and 4.6 percent per year for 2011-2020 period) is offset in its implications for price inflation, due to the fact that productivity is growing (see Table 5.2 above). Unit labour costs (ULCT) increase at a lower rate than actual wage rates.

Table 5.6: Baseline projections of price and wage inflation

Year	WT	PCONS	POT	PON	PG	PGDPFC	ULCT
1996	69.42	67.84	67.28	77.36	88.01	79.85	71.60
1997	95.22	82.14	78.56	83.59	98.63	81.88	92.52
1998	81.47	82.96	60.48	73.18	73.97	76.07	78.31
1999	78.25	58.97	56.06	56.25	66.32	55.43	83.57
2000	55.11	50.05	51.88	55.07	39.34	49.64	53.27
2001	31.87	58.82	67.24	55.29	58.37	53.72	44.51
2002	35.01	40.56	37.75	51.65	44.61	45.02	31.85
2003	23.94	21.83	19.52	22.05	29.73	23.54	13.30
2004	15.26	7.94	11.55	8.92	15.25	10.34	8.84
2005	3.39	6.14	9.67	4.60	9.46	5.61	5.19
2006	10.69	10.72	11.91	12.17	8.41	11.39	6.68
2007	4.38	4.13	1.66	6.80	4.38	4.76	2.11
2008	2.67	2.14	1.45	3.06	2.67	2.51	1.26
2009	0.40	1.13	0.65	0.63	0.40	1.35	-1.95
2010	1.31	0.72	0.86	-0.37	1.31	0.20	-1.12
2011	3.86	1.93	1.60	1.91	3.86	1.92	1.82
2012	4.00	2.58	1.64	3.38	4.00	2.75	1.95
2013	4.06	2.63	1.66	3.48	4.06	2.82	2.02
2014	4.13	2.68	1.68	3.55	4.13	2.89	2.09
2015	4.21	2.73	1.71	3.62	4.21	2.95	2.16
2016	4.29	2.78	1.73	3.70	4.29	3.02	2.24
2017	4.36	2.83	1.76	3.77	4.36	3.08	2.31
2018	4.44	2.88	1.78	3.84	4.44	3.15	2.38
2019	4.51	2.93	1.81	3.91	4.51	3.21	2.45
2020	4.58	2.98	1.83	3.97	4.58	3.28	2.52

The final Table 5.7 shows a series of economy-wide balances: the savings rate (SAVRAT), the public sector borrowing requirement (GBORR), the net trade balance (NTSVR), and the public sector debt (RDEBT), which are all expressed as a percentage of GDP.

Table 5.7: Baseline projection of macroeconomic balances

Year	SAVRAT (I)	GBORR (I)	NTSVR (I)	RDEBT (I)
1996	13.61	8.15	-6.47	44.75
1997	14.47	7.49	-5.83	42.56
1998	16.08	7.00	-3.48	41.85
1999	20.61	10.74	-3.41	49.99
2000	19.09	10.10	-7.29	52.92
2001	24.66	15.60	2.28	95.62
2002	24.78	14.23	-1.47	88.80
2003	23.17	10.76	-3.30	83.68
2004	20.59	6.21	-5.84	77.75
2005	15.69	0.80	-6.65	70.53
2006	13.29	0.11	-8.00	64.13
2007	13.38	-0.84	-8.40	57.51
2008	13.41	-0.01	-5.63	55.48
2009	13.39	3.07	-3.68	60.13
2010	13.45	3.41	-4.19	61.46
2011	13.53	3.39	-4.43	60.99
2012	13.61	3.23	-4.53	59.91
2013	13.68	3.02	-4.63	58.66
2014	13.76	2.79	-4.73	57.22
2015	13.83	2.52	-4.83	55.58
2016	13.89	2.22	-4.94	53.72
2017	13.96	1.89	-5.04	51.62
2018	14.02	1.52	-5.14	49.29
2019	14.07	1.12	-5.24	46.69
2020	14.13	0.68	-5.34	43.82

SAVRAT = Savings ratio; GBORR = Government borrowing requirement as % of GDP
NTSVR = Net trade balance as % or GDP; RDEBT = Public debt as % of GDP

The savings rate increases modestly, from a value of 13.3 percent in 2006 to a value of 14.1 percent by 2020. The public sector borrowing requirement starts off in balance in the year 2006, however the public balance turns to a deficit in 2009 due to revenue losses arising from the contraction in GDP. Public balances are projected to improve gradually and come close to balance as of 2020.

The net trade balance starts off in the year 2006 as a deficit of 8 percent of GDP, however the net trade deficit declines remarkably in 2008 and 2009 due to the sharp slow down in economic activity. Thereafter, the deficit fluctuates around 4-5 percent of GDP.

Finally, the government debt over GDP ratio starts off in 2006 with a value of 64 percent of GDP and declines in 2007 and 2008. However, due to the deterioration of the fiscal balances in 2009, it displays a remarkable increase. Following the gradual improvement in fiscal balances after the crisis, it starts to decline and retreats to around 44 percent of GDP by 2020. It should be noted that a very simple mechanism is used in the model to generate the public sector debt, as the accumulated borrowings/surpluses. The reality may be more complex, depending on the exact structure of debt.

5.5 Testing the Model with Policy Shocks

In this section, the properties of the Turkish HERMIN model using a series of simulated shocks to exogenous variables are examined. In order to examine the full medium-run properties of the model, it is necessary to simulate the model over a long period. To do this, a baseline projection for the period 2007 to 2020 is used. After shocking one or more variables from a given year (2007) 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, four cases that are particularly important are presented here. These are:

i. The effects of changes in world output/demand (i.e., the components of OWM);

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;

5.5.1 A Shock to World Output (OWM)

To investigate the effect of world output shocks on the model, all the separate components that make up OWM (in this example, a trade-weighted measure of imports in the main trading partners of Turkey) were permanently raised by 10 percent above their baseline trajectories. It should be kept in mind that most of Turkish exports are directed to the EU countries. Hence, this is effectively a shock that explores the consequences for the Turkish economy of a rise in import demand in its EU trading partners, where no other exogenous world variable is altered (e.g., unemployment, prices, etc.).

Table 5.8 shows the effect of this shock on total GDP (GDPFC), as well as on manufacturing sector output (OT), building and construction output (OBC) and market services sector output (ON). The consequences for manufacturing (OT) stem largely from the calibration of the OT (manufacturing output) equation (where the elasticity of OT with respect to OWM was 0.325). The impacts on building/construction and on market services arise as an indirect consequence of the external stimulus transmitted through the exposed trading sector.

This result is very different from that of the small, open economies of - say - the Baltic States, Ireland or Slovenia. Indeed, it is a more pessimistic result that than of Poland, the largest of the

new EU member state economies. Table 5.8 suggests that Turkey is not as open, or as closely integrated into the EU Single Market as are many of the new EU member states. The table also suggests that a closer look at the tradable sector in the HTR5 model would be useful, where manufacturing and some of market services might be disaggregated so that the links to the world economy are understood better.

Table 5.8: Effects of 10% rise in level of "world" output
(percentage change relative to baseline)

Date	OWM	OT	ON	OBC	GDPFC
2006	0.00	0.00	0.00	0.00	0.00
2007	10.00	3.79	0.48	0.61	1.37
2008	10.00	3.61	0.45	0.55	1.29
2009	10.00	3.53	0.36	0.48	1.15
2010	10.00	3.48	0.32	0.48	1.12
2011	10.00	3.43	0.28	0.47	1.09
2012	10.00	3.37	0.25	0.47	1.07
2013	10.00	3.32	0.21	0.46	1.04
2014	10.00	3.26	0.17	0.45	1.02
2015	10.00	3.20	0.13	0.44	0.99
2016	10.00	3.14	0.09	0.43	0.95
2017	10.00	3.08	0.05	0.42	0.92
2018	10.00	3.02	0.00	0.40	0.88
2019	10.00	2.95	-0.04	0.39	0.84
2020	10.00	2.88	-0.09	0.37	0.80

OWM: "world" import; GDPFC: real GDP at factor cost; OT: GDP in manufacturing; OBC: GDP in building & construction; ON: GDP in market services

5.5.2 A Public Employment Shock (LG)

Table 5.9 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 initially to an increase of about 322 thousand new jobs in the sector in the year 2007. The increase in expenditure on public sector wages is assumed to be financed by running a larger deficit (if necessary) and not by increasing tax rates or cutting public expenditure elsewhere.

Table 5.9: Effects of 10% increase in public sector employment
(Change relative to baseline, thousands)

Date	LG (I)	LT	LLN	LBC	L (I)	Multiplier
2006	0.0	0.0	0.0	0.0	0.0	0.00
2007	322.4	1.3	13.1	-0.8	336.0	1.04
2008	328.9	-6.3	15.9	-1.7	336.8	1.02
2009	335.5	-3.8	17.7	-1.7	347.6	1.04
2010	342.2	-3.3	19.1	-1.6	356.5	1.04
2011	349.0	-2.8	21.0	-1.5	365.7	1.05
2012	356.0	-2.2	23.1	-1.4	375.5	1.05
2013	363.1	-1.6	25.4	-1.3	385.6	1.06
2014	370.4	-0.8	27.9	-1.2	396.3	1.07
2015	377.8	0.0	30.6	-1.1	407.3	1.08
2016	385.3	0.9	33.6	-0.9	418.9	1.09
2017	393.0	1.9	36.8	-0.7	431.0	1.10
2018	400.9	3.0	40.2	-0.5	443.6	1.11
2019	408.9	4.2	44.0	-0.3	456.8	1.12
2020	417.1	5.5	48.1	-0.1	470.6	1.13

LG = employment in non-market services; L = total employment
LT = manufacturing; LLN = Market services; LBC = Building & Construction

As can be seen from Table 5.9, total employment increases initially by only 336 thousands as a result of the Keynesian demand mechanism (i.e., when the 322 extra public sector employees spend their wages). In other words, the impact multiplier is only 1.04. This multiplier increases to about 1.13 at the end of the simulation period.[32] It should be emphasised that this simulation was run under the assumption that tax rates are exogenous and there is no additional fiscal crowding-out effect.

5.5.3 A Shock to Government Investment (IGV)

The next shock that is examined relates to an increase in public investment in infrastructure. Table 5.10 shows the effect of a permanent 10 percent increase in nominal public investment. As can be seen from Table 5.10, there is an initially low Keynesian multiplier effect of 0.99 (i.e., the change in real GDP (GDPE) divided by the shock to real public investment (IG)). The multiplier on GDP rises to 1.02 by the year 2011, and to 1.43 by the year 2020.

Once again, it should be stressed that the extra public expenditure to support increased public investment is financed by running a higher budget deficit. So, there is no fiscal crowding out due to higher tax rates or higher interest rates.

Table 5.10: Effects of a 10% rise in the level of public investment
(change relative to baseline, constant prices)

Date	IG (I)	I (I)	CONS (I)	X (I)	M (I)	NTS (I)	GDPE (I)	Multiplier
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
2007	754.5	1093.1	400.4	448.4	742.2	-293.8	749.8	0.99
2008	784.8	1110.5	464.2	404.1	725.0	-320.9	751.9	0.96
2009	768.5	1079.8	492.4	384.4	648.1	-263.7	730.7	0.95
2010	761.4	1093.7	531.5	410.1	688.0	-277.8	750.0	0.98
2011	790.2	1148.1	598.4	443.5	746.6	-303.1	805.0	1.02
2012	815.2	1199.4	672.1	475.2	807.5	-332.3	859.5	1.05
2013	840.6	1252.6	753.4	509.7	873.6	-363.9	918.3	1.09
2014	866.4	1308.3	842.3	546.5	945.4	-398.8	981.3	1.13
2015	892.7	1366.8	939.4	585.9	1023.4	-437.4	1049.1	1.18
2016	919.5	1428.4	1045.6	628.1	1108.1	-480.0	1122.1	1.22
2017	946.7	1493.3	1161.3	673.0	1200.1	-527.0	1200.6	1.27
2018	974.3	1561.7	1287.4	721.0	1300.0	-578.9	1285.1	1.32
2019	1002.3	1633.9	1424.5	772.3	1408.5	-636.2	1376.1	1.37
2020	1030.8	1710.2	1573.5	826.9	1526.3	-699.3	1473.9	1.43

IG = real public investment; I = total investment; GDPE = GDP (expenditure); X = Exports; CONS = private consumption; M – Imports; NTS = Net trade surplus

5.5.4 A Shock to All Exogenous Price Levels

Here a shock that raises the level of all exogenous prices permanently by 10 percent is carried out, mainly in order to test the price homogeneity that was imposed on the model. The prices involved are as follows: the price of industrial output in the world (with various subcomponents); the import price (PM); and the agricultural output price (which is treated as exogenous).

Table 5.11 shows the response of Turkish prices and costs. The slight delay in adjustment is due mainly to the phased adjustment of output prices in market services (PON) and building &

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[32] Reference to Appendix A5.5 shows that the shock to LG is in the form of a 10 percent increase in numbers for each year from 2007 to 2020. Since the actual LG numbers in the projection are growing at an assumed rate of 2 percent per year, the increase in numbers due to the shock will also rise over time, from an extra 322.4 thousand in 2007 to 417.1 thousand by 2020.

construction (POBC). Not all of the world price shock is transmitted into the Turkish prices and wages, but domestic prices do increase by about 80 percent of the world price level shock.

Table 5.11: Effects of 10% increase in all exogenous price levels
(percentage change relative to baseline)

Date	PWORLD	PM	POT	PON	PGDPFC	PCONS	WT	ULCT	RULCT
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	10.00	9.90	7.42	5.22	6.31	6.78	6.90	6.95	-0.44
2008	10.00	9.90	7.41	8.54	8.11	8.18	6.66	6.79	-0.57
2009	10.00	9.90	7.43	8.47	8.11	8.16	6.67	6.83	-0.55
2010	10.00	9.90	7.45	8.51	8.14	8.20	6.71	6.86	-0.55
2011	10.00	9.91	7.48	8.52	8.16	8.22	6.75	6.90	-0.54
2012	10.00	9.91	7.52	8.53	8.17	8.24	6.80	6.94	-0.54
2013	10.00	9.91	7.56	8.53	8.18	8.27	6.86	6.99	-0.53
2014	10.00	9.91	7.60	8.53	8.20	8.29	6.91	7.04	-0.52
2015	10.00	9.91	7.63	8.54	8.21	8.31	6.96	7.09	-0.51
2016	10.00	9.91	7.67	8.54	8.23	8.34	7.01	7.14	-0.50
2017	10.00	9.92	7.71	8.55	8.25	8.36	7.07	7.18	-0.49
2018	10.00	9.92	7.75	8.55	8.26	8.39	7.12	7.23	-0.48
2019	10.00	9.92	7.78	8.56	8.28	8.41	7.17	7.28	-0.47
2020	10.00	9.92	7.82	8.57	8.29	8.43	7.22	7.33	-0.46

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

5.5.5 Conclusions on Responses to Shocks

The shocks illustrate some of the properties of the Turkish HERMIN model. For example, world market conditions feed into the economy of Turkey mainly through the internationally exposed manufacturing sector but also indirectly through the market services sector. External price shocks pass quickly into the economy, under the assumption of a fixed exchange rate. Public employment and investment shocks have relatively modest multiplier 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.

6. Public Investment Transmission Mechanisms

6.1 Introduction

The structure of the Turkish HERMIN model was designed from its inception to facilitate the macro evaluation of the impacts of public investment policies similar in form to EU Structural and Cohesion Funds (see Bradley, Kangur and Lubenets, 2004, for a complete set of early references). This chapter describes the manner in which practical model-related aspects of the public investment policy evaluation methodology and transmission mechanisms are handled, in order to explain to a potential user of the model how it is implemented.

First, the way in which the published public investment data can be computerised in a flexible way is described[33]. In other words, a situation where the total sum of public finance may change, and where its distribution across various types of public investment categories can also change has to be handled. Such flexibility is needed for the system, since it is often necessary to examine a wide series of alternative financial packages.

Then, the model-related mechanisms through which the public investment policy impacts are modelled are summarised and the type of information needed to carry out an impact evaluation as accurately as possible is described. It should also be noted that as Turkey is not yet subject to EU Structural Funds, the mechanisms described in this chapter are illustrative for the time being.

6.2 Inserting Public Investment Policies into the Model

What follows is the adaptation of the public investment mechanisms of the kind used in EU Structural Funds to be suitable for use when the policy being analysed is a purely national, Turkish, policy. However, it is convenient to keep the model variable notation that was developed and tested in EU cohesion policy contexts. So, it is referred to EU funding, domestic (Turkish) public funding, and domestic (Turkish) private funding, even in situations where the EC funding is zero. Obviously one can analyse a purely Turkish public investment policy by simply setting the EU component to zero.

In its most simple form, the public investment data, as decided by the planners, consists of time series for the total Community (EC) funding allocation to the recipient state, usually expressed in millions of current euro. In each country, the HERMIN notation for these basic data is GECSFEC_E, and (for example) they might be given for the years 2007-2013 inclusive, the present EU budgetary programme.

As part of the negotiations with the European Commission, a domestic co-finance ratio is agreed. This percentage is designated as RDCOFIN in the formulae below. The total community funding and domestic public expenditure (EC+DP) is then split between three main economic categories using the national shares implicit in the detailed sectoral and regional investment programmes contained in the national policy plan. These economic categories are physical infrastructure, human resources, and direct aid to the productive sectors.

The further allocation of the direct aid to productive sectors is carried out using assumed shares (as between manufacturing and market services, since it is assumed that no funds will be devoted to agriculture).

The EC total expenditure contribution (say, 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 the plan. This is converted to

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[33] In the case of EU Structural Funds, the "financial tables" contain the published data on the financial allocations of EU assistance aid, and are agreed between the European Commission and the recipient member state.

national currency (GECSFEC) using exchange rate for a selected base period. This is usually taken as the exchange rate just before the programme starts to be implemented, and will be referred to as TREUR. Consequently,

$$GECSFEC = GECSFEC\_E * TREUR$$

The implied domestic public (DP) co-finance contribution (GECSFDP) is derived using an assumed domestic co-finance ratio (RDCOFIN, the percent of the total of EC and domestic public finance that is the domestic co-finance). RDCOFIN is defined by us as follows[34]. If GECSFEC is the EU funding contribution, and GECSFDP is the domestic public co-finance contribution, then:

$$RDPCOFIN=100*GECSFDP/ (GECSFEC+GECSFDP)$$

In the HERMIN model, the domestic public co-finance ratio (RDPCOFIN) is taken as a datum and the above definition is transformed to define the level of domestic co-funding, given a specified level of EU funding, i.e., the above equation is solved for GECSFDP:

$$GECSFDP = (RDPCOFIN/(100-RDPCOFIN)) * GECSFEC$$

The implied domestic private (PR) co-finance contribution (GECSFPR), is similarly derived using an assumed domestic co-finance ratio (RPRCOFIN percent), defined as follows. Total EC plus DP finance is taken as the base for calculating the domestic private co-finance ratio.

$$RPRCOFIN=100*GECSFPR/ (GECSFEC+GECSFDP)$$

In the HERMIN model the above equation is solved for the level of domestic private co-finance (GECSFPR):

$$GECSFPR = (RPRCOFIN/100) * (GECSFEC+GECSFDP)$$

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

$$GECSF = GECSFEC + GECSFDP + GECSFPR$$

This total (GECSF) is then disaggregated into 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), DP (Domestic Public) and PR (Domestic Private) 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.

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[34] We use the term "domestic public co-finance ratio" (RDPCOFIN) strictly according to the definition used above. It should not be confused with other, administrative uses of a similar term.

Physical Infrastructure (PI):

The amounts being spent to fund investment in physical infrastructure are as follows:

$$IGVCSFEC = (RIGVCSF/100) * GECSFEC$$
$$IGVCSFDP = (RIGVCSF/100) * GECSFDP$$
$$IGVCSFPR = (RIGVCSF/100) * GECSFPR$$

where the EC, DP and PR notation is as explained above. What these equations in the model do is allocate portions of total cohesion policy expenditure (GECSFXX) to investment expenditures on physical infrastructure.

Human Resources (HR):

The amounts being spent to fund investment in human resource activities are as follows:

$$GTRSFEC = (RGTRSF/100) * GECSFEC$$
$$GTRSFDP = (RGTRSF/100) * GECSFDP$$
$$GTRSFPR = (RGTRSF/100) * GECSFPR$$

where the EC, DP and PR notation is as explained above. What these equations in the model do is allocate portions of total cohesion policy expenditure (GECSFXX) to investment expenditures on human resources.

Direct Aid to the Productive Sectors (APS, residual):

The amounts being spent on activities to aid the productive sectors are determined residually as follows:

$$TRIEC = GECSFEC - (IGVCSFEC+GTRSFEC)$$
$$TRIDP = GECSFDP - (IGVCSFDP+GTRSFDP)$$
$$TRIPR = GECSFPR - (IGVCSFPR+GTRSFPR)$$

where the EC, DP and PR notation is as explained above.

Direct aid to the productive sectors (TRIXX) is disaggregated into its three main sectoral allocations (manufacturing (T), Market Services (N) and (residually, Agriculture (A)).[35] The allocation of sectoral shares (as between T, N and A sectors) is usually independent of the source of the funding (i.e., between EC, DP and PR)

Manufacturing (Percentage share = RTRIT):

$$TRITEC = (RTRIT/100) * TRIEC$$
$$TRITDP = (RTRIT/100) * TRIDP$$
$$TRITPR = (RTRIT/100) * TRIPR$$

What these equations in the model do is allocate portions of cohesion policy expenditure on aid to the productive sectors (TRIXX) to aid expenditures on manufacturing.

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[35] Note that no funding is allocated to the general government sector, G. Only the three private sectors T, N and A receive aid. Of course much of the subsequent investment projects involving physical infrastructure are carried out by the building and construction sector. In other words, the B&C sector is an indirect beneficiary of funding, but not a "direct" beneficiary.

Market Services (Percentage share = RTRIM):

$$TRIMEC = (RTRIM/100) * TRIEC$$
$$TRIMDP = (RTRIM/100) * TRIDP$$
$$TRIMPR = (RTRIM/100) * TRIPR$$

What these equations in the model do is allocate portions of cohesion policy expenditure on aid to the productive sectors (TRIXX) to aid expenditures on market services.

Agriculture (residual):

$$TRIAEC = TRIEC – (TRITEC+TRIMEC)$$
$$TRIADP = TRIDP – (TRIMEC+TRIMDP)$$
$$TRIAPR = TRIPR – (TRIMPR+TRIMPR)$$

Total aid to the productive sectors (APS) is further disaggregated into two main economic categories; R&D and other direct aid. The percentage share of total APS funding (TRI) (=TRIEC+TRIDP+TRIPR) going to R&D is defined as RRDTCSF, defined as:

$$RRDTCSF = 100*(TRIRD/TRI)$$

In the model, the above equation is used to determine TRIRD, given values for RRDTCSF and TRI:

$$TRIRD = (RRDTCSF/100) * TRI;$$

The accumulation of the constant price version of these funds directed at R&D activities (TRIRD) can be used in the model to derive a measure of a "stock" of R&D (KRTRIRD), and is explained in Section 6.5.

6.3 Handling Public Physical Infrastructure Impact Analysis

The HERMIN model assumes that any cohesion policy 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).[36] Hence, the total public and private NSRF infrastructure expenditure (IGVCSF) is defined in the model as follows (in current prices):

$$IGVCSF = IGVCSFEC + IGVCSFDP + IGVCSFPR$$

Inside the HERMIN model, these cohesion policy-related expenditures are converted to real terms (by deflating the nominal expenditures by the investment price) and are then added to any existing (non-cohesion policy) real public 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):

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

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[36] 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 no longer appropriate. But in what follows we have left the notation unchanged, but, of course, the appropriate concepts are being used.

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

$$KGINFR = KGINF / KGINF_0$$

It is this ratio that enters into the calculation of any spillovers (or externalities) associated with improved infrastructure.

As regards the public finance implications of cohesion policy, 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 (if any) of EC cohesion policy-related aid subventions (IGVCSFEC), since such investment expenditures are provided by the EC and are not a cost on the local exchequer. Whether or not the post-cohesion policy public sector deficit rises or falls relative to the no-cohesion policy baseline will depend both on the magnitude of domestic co-financing and the stimulus imparted to the economy by the cohesion policy shock. If there is a very generous rate of EC aid, i.e., a very low domestic public co-finance ratio, then the budgetary position may actually improve, as will be seen when the model is used to simulate actual examples of co-financed investment policy programmes.

In the complete absence of any externality (or spillover) mechanisms, the HERMIN model initially determines the demand (or Keynesian) effects of the cohesion policy infrastructure programmes, the supply effects being only included to the extent that they are captured by any induced shifts in relative prices or by any tightening of the labour market. This transitory effect will depend on the size of the policy multipliers, which will be known from the testing results of the HERMIN model reported in Section 5 earlier.

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

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

where η is the spillover elasticity. The way in which the spillover elasticity can be approximately calibrated numerically, drawing on the empirical growth theory research literature, is explained elsewhere (Bradley and Untiedt, 2006). See Romp and de Haan (2007) for a comprehensive survey of the international literature on the impact of physical infrastructure. In any model-based simulations, the externality effects can be phased in over an extended period, reflecting the implementation stages of the cohesion policy 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[37].

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

i. The <u>direct</u> influence on manufacturing output (OT) and market services output (ON) of improved infrastructure (KGINF), i.e. any rise in the stock of infrastructure relative to the no-cohesion policy baseline (KGINFR) will be reflected in a direct induced rise in output, by an amount that will depend on the size assumed for the spillover elasticity.

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[37] For example, if a motor way is being constructed between city A and city B, and no parts are opened until it is complete, then there will be no spillover benefits until after completion. In such a case, the "phase-in" process would only start operating after completion, and would be zero during the implementation phase.

ii.   Total factor productivity (TFP) in manufacturing (T) as well as in market services (N) is increased, once again by an amount that will depend on the size assumed for the spillover elasticity.

The first type of externality is an unqualified benefit to the economy, and directly enhances its performance in terms of increased manufacturing and market services 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.

6.4 Handling Public Policy Human Resources Impact Analysis

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

$$GTRSF = GTRSFEC + GTRSFDP + GTRSFPR$$

As regards the public finance implications, 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 sector deficit (GBOR) is limited by the extent of CSF aid subventions (GTRSFEC).

Since the complex institutional detail of the many ESF human resource (HR) training and education programmes cannot be handled in a stylised macroeconomic model like HERMIN, one needs to simplify drastically if these mechanisms are to be included in the model. Each trainee or participant in a training course is assumed to be paid an average annual income (WTRAIN), taken to be a specified 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).   An overhead on total wage costs to take account of buildings, equipment, materials, etc (OVERHD), and a trainee-instructor ratio (TRATIO) are assumed[38].   Hence, total HR expenditure (GTRSF) can be written as follows (in nominal terms):

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

where SFTRAIN is the number of trainees being supported and LINS is the number of instructors, defined as SFTRAIN/TRATIO.[39] In other words, the wage bill for trainers and trainees, plus the mark up to cover building, machinery and equipment, exhausts the funding. This formula is then inverted in the HERMIN model and used to estimate the approximate number of extra trainees per year that can be funded from investment policy for a given total expenditure GTRSF on human resources, i.e.,

$$SFTRAIN = (GTRSF/(1+OVERHD)) / (WTRAIN + WN/TRATIO)$$

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[38] Standard parameter values of OVERHD=0.30, TMUP=0.30 and TRATIO=15 are initially assumed, but these can be modified as more detailed information becomes available. In other words, a building/equipment overhead of 30%, an income support payment to trainees of 30% of the average industrial wage, and a trainee-instructor ratio of 15:1. Obviously, these can be varied, to reflect specific country Social Fund preferences.
[39] 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.

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

$$SFWAG = SFTRAIN*WTRAIN + LINS*WN$$

The number of cohesion policy-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 percent[40]:

$$KSFTRAIN = SFTRAIN + (1-0.05) * KSFTRAIN(-1)$$

In order to quantify the increase in the stock of human capital (measured in trainee years), it is necessary to define the initial pre-cohesion policy stock of human capital, $KTRAIN_0$. This is a conceptually difficult challenge, and it has to be simplified drastically. The measure of human capital is based on the average number of years of formal education and training that the labour force has achieved prior to the implementation of cohesion policy. So, the complex details of the education system can be simplified and human capital can be stylised as follows:

$$KTRAIN_0 = YPLS*FPLS*DPLS + YHS*FHS*DHS + YNUT*FNUT*DNUT + YUT*FUT*DUT$$

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[41]

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 trainees (KSFTRAIN) is added to the exogenous baseline stock of trained workers ($KTRAIN_0$) and is divided by the baseline stock to give the relative improvement in the proportion of trained workers associated with the cohesion policy-funded HR programmes:

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[40] If the HR programmes are badly designed and ineffective, obviously the raw stock proxy, KSFTRAIN will be a poor guide to future benefits. However, that can be handled by imposing low, or zero spillover benefits.

[41] 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 university education, this is very unlikely to be true in practice. 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 are becoming the norm throughout the EU, we might discount these years relative to years of higher secondary, tertiary non-university and tertiary university education. 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. However, this is a rather extreme assumption.

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

and it is this ratio (KTRNR) that enters into the calculation of spillovers (or 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 cohesion policy human resource programmes. These effects are limited in magnitude. In addition, a sizeable fraction of the HR policy 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 spillover (or externality) effects to augment the demand-side impacts of the cohesion policy human resource programmes. In each case, the strength of the spillover effect is defined as a fraction of the improvement of the stock of 'trained' workers over and above the baseline (no-cohesion policy) projected level, i.e.,

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

here η is the spillover (or externality) elasticity. The way in which the externality elasticity can be approximately calibrated numerically, drawing on the empirical growth theory research literature, is explained elsewhere (Bradley and Untiedt, 2008). See Sinaesi and van Reenen (2002) for a comprehensive survey of the international literature on the impact of human capital. In the model-based simulations, the externality effects can be phased in over an extended period, reflecting the implementation stages of the cohesion policy programmes and the fact that benefits from improved human resources may only be exploited with a lag by the private sector in terms of increased activity.

Two types of spillover effects associated with human capital are introduced into the HERMIN model[42]:

i. The <u>direct</u> influence on manufacturing and market services output (OT and ON) of improved human capital, i.e. any rise in the "stock" of human capital relative to the no-cohesion policy baseline (proxied by KTRNR) will be reflected in an induced rise in output.

ii. <u>Labour embodied</u> technical change in manufacturing (T) and in market services (N) is increased, where a given output can now be produced by fewer workers or where any increased level of sectoral output can become more skill intensive but less employment intensive.

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[42] 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 HR/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.

6.5 Handling Public Policy R&D Impact Analysis

Using published data on R&D expenditures, an historical stock of R&D (KRTRIRD) can be constructed. A total stock of historical R&D is generated by accumulating pre-plan real expenditures on R&D (i.e., deflated nominal expenditures), using the perpetual inventory formula. The value of real R&D (RRandD) in the initial year (say, 1987) is assumed to be 0.5 percent of GDP in 1987. To initialise the stock KRTRIRD for 1987, it is set at 10 years accumulated RRandD (1987). Given the somewhat ephemeral nature of R&D, a relatively high, 8 percent, rate of depreciation is assumed. The generations are carried out in TSP, and are shown below:

SMPL 1987 1987;
KRTRIRD=10.0*(0.5/100)*GDPFC;
SMPL 1988 2006;
GENR KRTRIRD=RRandD+(1-0.08)*KRTRIRD(-1);

The HERMIN model assumes that any plan expenditure on R&D that is directly financed by EC aid subvention is matched both by a domestically financed public expenditure and an (often 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 cohesion policy R&D expenditure (TRIRD) is defined in the model as follows (in current prices):

$$TRIRD = (RRDTCSF/100) * (TRIEC+TRIDP+TRIPR)$$

Inside the HERMIN model, these cohesion policy-related expenditures are converted to real terms (by deflating the nominal expenditures by an appropriate price) and are then added to any existing (non-cohesion policy) real R&D investment, determining total real investment in R&D (RTRIRD).

The real TRIRD expenditures (RTRIRD) are accumulated to obtain a real stock of R&D (KRTRIRD)[43]. However, when it comes to the public sector accounts, private transfers (TRIPR) are excluded from public capital expenditure (GEKCSF).

Total "real" R&D investment expenditures is defined as the sum of any real non-plan R&D investments (RRANDD) and additional APS R&D investments (TRIRD/PCONS, where the deflator used in the consumption price)

$$RTRIRD = RRANDD+TRIRD/PCONS$$

R&D investment is accumulated into a notional stock (KRTRIRD) by a perpetual inventory formula, assuming an 8 percent 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 (KRTRIRD0$_0$). Spillovers are associated with increases in this ratio (KRTRIRDR).

$$KRTRIRDR=KRTRIRD / KRTRIRD_0$$

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[43] If the R&D programmes are badly designed and ineffective, obviously the raw stock proxy, KRTRIRD will be a poor guide to future benefits. However, that can be handled by imposing low, or zero spillover benefits.

It is this ratio that enters into the calculation of any externalities (spillovers) associated with an improved stock of R&D, as described above. The remainder of aid to productive sectors (APS), i.e., the element that is not devoted to R&D activities, is assumed to have only transitory Keynesian impacts, and no long-term spillover impacts.

As regards the public finance implications of the APS expenditure, 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 APS-related aid subventions. Whether or not the post-plan policy public sector deficit rises or falls relative to the pre-plan policy baseline will depend both on the magnitude of domestic co-financing and the stimulus imparted to the economy by the cohesion policy shock.

In the complete absence of any externality (or spillover) mechanisms, the HERMIN model calculates the demand (or Keynesian) effects of the APS-funded R&D programmes, the supply effects being only included to the 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 the model reported in Section 5 earlier.

Now it is time to switch to various spillover (or externality) effects to augment the conventional demand-side impacts of the APS-funded R&D programmes in order to capture likely additional supply-side benefits. In each case, the strength of the spillover effect is defined as a fraction of the improvement of the stock of R&D over and above the baseline (no-cohesion policy) projected level (KRTRIRDR), i.e.,

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

where η is the spillover elasticity. The way in which the externality elasticity can be approximately calibrated numerically, drawing on the empirical growth theory research literature, is described elsewhere (Bradley and Untiedt, 2008). See Congressional Budget Office (2005) for a comprehensive survey of the international literature on the impact of R&D. In any model-based simulations, the spillover effects can be phased in over an extended period, reflecting the implementation stages of the ALS R&D 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.

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

i. The <u>direct</u> influence on manufacturing and market services output (OT and ON) of improved R&D (KRTRIRD), i.e. any rise in the stock of R&D relative to the no-cohesion policy baseline (KRTRIRDR) will be reflected in an induced rise in output.

ii. <u>Total factor productivity</u> (TFP) in manufacturing (T) as well as in market services (N) is increased.

As in the case of the other spillovers (from enhanced stocks of physical infrastructure and human capital), the first type of spillover above 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.

6.6 Implications for Equations in HERMIN

In the previous three sections, the mechanisms through which improved stocks of physical infrastructure, human resources and R&D can create benefits for the economy in terms of increased output and higher productivity have been described. In this concluding section it is set out exactly how these mechanisms feed into the output and factor demand systems in the HERMIN model.

The crucial "spillover" elasticities are defined as follows (with suggested default values of the elasticities shown in brackets):

Manufacturing output

ETATQI = Output spillover - infrastructure (0.20)
ETATQH = Output spillover - human capital (0.20)
ETATQR = Output spillover - R&D (0.05)

Manufacturing productivity

ETATPI = Labour productivity spillover - infrastructure (0.10)
ETATPH = Labour productivity spillover - to human capital (0.10)
ETATPR = Labour productivity spillover - R&D (0.05)

Market services output

ETAMQI = Output spillover - infrastructure (0.05)
ETAMQH = Output spillover - human capital (0.05)
ETAMQR = Output spillover - R&D (0.01)

Market services productivity

ETAMPI = Labour productivity spillover - infrastructure (0.05)
ETAMPH = Labour productivity spillover - human capital (0.05)
ETAMPR = Labour productivity spillover - R&D (0.025)

6.6.1 Manufacturing (T) Sector Effects:

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. The domestic demand factors represent the conventional Keynesian mechanism. The driving variables are as follows:

OWM   : World demand (proxied by world imports)
ULCT/POT   : The real unit cost of labour
FDOT   : Sectoral weighted domestic demand
POT/PWORLD: Relative domestic-to-world prices
TOT   : A time trend, to capture other shifts in the drivers of OT

Infrastructure, human capital and R&D spillovers are included as options in the modification of OT. 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)

In the case of the Turkish model, the calibrated behavioural coefficients in the OT equation are shown in Table 4.1:

AOT1 = 3.732;
AOT2 = 0.325;   {Elasticity of OT wrt OWM}
AOT3 = -0.25;   {Elasticity of OT wrt RULCT}
AOT4 = 0.675;   {Elasticity of OT wrt FDOT}
AOT5 = -0.25;   {Elasticity of OT wrt PCOMPT}
AOT6 = 0.00642;   {Autonomous time trend}

The equation in the model that determines GDP in manufacturing (OT) is modified as follows, to take account of the presence of spillover mechanisms. In this equation, the exogenous variables DETATQI, DETATQH and DETATQR are "phase-in" mechanisms that permit one to take account of the fact that some multi-year investment programmes may only yield supply-side benefits after a lag. In all the current simulations, these variables are set so as to phase in the supply-side impacts uniformly over a five year period. In other words, the full impact of the spillover benefit, as quantified by the spillover elasticity and the size of the increase in the underlying stock, only comes on stream after five years. As more information comes available on the actual progress of the investment programmes, these "phase-in" variables can be reset to reflect reality.

log(OT)= AOT1 + (DETATQI*ETATQI)*log(KGINFR)
                + (DETATQH*ETATQH)*log(KTRNR)
                + (DETATQR*ETATQR)*log(KRTRIRDR)
                + AOT2*log(OWM)
                + AOT3*log(RULCT)
                + AOT4*log(FDOT)
                + 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. Technical progress is assumed to be Hicks-neutral.

The CES production function parameters (AT, SIGT, LAMT and DELT) are defined as follows, with the Turkish calibrated values shown.

AT   = 5.44091 ; {Scale parameter}
SIGT = 0.50000 ; {Elasticity of substitution: 0 < SIGT < 1}
LAMT = 0.019206 ; {Rate of Hicks-neutral technical progress}
DELT = 0.78423 ; {Weight for capital input}

Infrastructure and R&D also 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

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internalised. This is implemented through the scale parameter (AT), augmented by spillover mechanisms (renamed ATX). The role of human resources will be treated later.

$$ATX=AT * (KGINFR)\text{^}(DETATPI*ETATPI)$$
$$* (KRTRIRDR)\text{^}(DETATPR*ETATPR);$$

Investment demand (IT) is the first part of the two-equation joint factor demand system.[44]

$$log(IT/OT) = -log(ATX) - LAMT*TT$$
$$+ SIGT/(1-SIGT)*log(1-DELT)$$
$$+ SIGT/(1-SIGT) * log ($$
$$(DELT/(1-DELT))\text{^}(SIGT)*ERFPT\text{^}(1-SIGT) + 1.0)$$
$$+ TRITEOT;$$

Note that all direct aid to manufacturing (i.e., the manufacturing share of total APS) is included as a boost to manufacturing investment (TRITEOT). Hence, during the implementation phase of any cohesion policy programme, there is a Keynesian boost to the economy, operating through an exogenous increase in manufacturing investment. After the programme is terminated, this vanishes. However, the R&D element continues to have supply-side spillover impacts that operate through the variable KRTRIRDR.

The capital stock can be recovered using the standard perpetual inventory formula:

$$KT=IT+(1-DEPTRAT)*KT(-1);$$

Labour demand (LT) is the second part of the two-equation 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.

$$log(LT/OT) = -(DETATPH*ETATPH)*log(KTRNR)-log(ATX)-LAMT*TT$$
$$+ SIGT/(1-SIGT)*log(DELT)$$
$$+ SIGT/(1-SIGT) * log($$
$$(DELT/(1-DELT))\text{^}(-SIGT)*ERFPT\text{^}(SIGT-1) + 1.0);$$

6.6.2 Market Services (N) Sector Effects:

GDP arising in the market services sector (ON) is determined by weighted domestic demand (FDON) and a time trend to capture residual factors (TON).

Infrastructure, human capital and R&D spillovers are included as options in the modification of ON. Note that in the baseline investment plan simulation the ratios KGINFR, KTRNR and KRTRIRDR are set to unity. Spillovers in the N-sector are more problematic than in the T-sector, and the

---

[44] For the complete derivation of the highly non-linear factor demand system, using the two-factor input CES production function, refer Bradley and Fanning (1984, pp. 309-312).

default elasticities in ON are usually assumed to be lower than in OT, based on the international literature (see Bradley and Untiedt, 2006 for references).

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)

In the case of the Turkish model, the calibrated behavioural coefficients in the ON equation are as follows:

AON1 = 5.031 ;
AON2 = 0.4728 ;   {Elasticity of ON wrt FDON}
AON3 = 0.0276 ;   {Autonomous time trend}

The equation in the model that determines GDP in Market Services (ON) is modified as follows, to take account of the presence of spillover mechanisms. As in the case of manufacturing, the exogenous variables DETATQI, DETATQH and DETATQR are "phase-in" mechanisms that permit one to take account of the fact that some multi-year investment programmes may only yield supply-side benefits after a lag.

log(ON) = AON1 + (DETANQI*ETANQI)*log(KGINFR)
                + (DETANQH*ETANQH)*log(KTRNR)
                + (DETANQR*ETANQR)*log(KRTRIRDR)
                    + AON2*log(FDON)
                    + AON3*TON ;

Investment (IN) and labour demand (LLN) are derived using cost minimization, using a semi putty-clay CES production function with constant returns to scale. ERFPN is the expected relative factor price ratio and TN is time. Technical progress is assumed to be Hicks-neutral.

The CES production function parameters (AN, SIGN, LAMN and DELN) are defined as follows, with the Turkish calibrated values shown.

AN   = 9.00056   ; {Scale parameter}
SIGN = 0.58867   ; {Elasticity of substitution: 0 < SIGN < 1}
LAMN = 0.0019795 ; {Rate of Hicks-neutral technical progress}
DELN = 0.90225   ; {Weight for capital input}

There is a total factor productivity externality, due to infrastructure and R&D, as in the T-sector (see above). The scale parameter (AN), is augmented by spillover mechanisms (renamed ANX)

ANX = AN * (KGINFR)^(DETANPI*ETANPI)
              * (KRTRIRDR)^(DETANPR*ETANPR) ;

Investment demand (IN) is the first part of the two-equation joint factor demand system.

log(IN/ON) = -log(ANX) - LAMN*TN
          + SIGN/(1-SIGN)*log(1-DELN)
          + SIGN/(1-SIGN) * log(
              (DELN/(1-DELN))^SIGN*ERFPN^(1-SIGN)+ 1.0)
          + TRINEOT ;

Note that all direct aid to market services (i.e., the market services share of total APS) is included as a boost to market services investment (TRINEOT). Hence, during the implementation phase of any cohesion policy programme, there is a Keynesian boost to the economy, operating through an exogenous increase in market services investment. After the programme is terminated, this vanishes. However, the R&D element continues to have supply-side spillover impacts that operate through the variable KRTRIRDR.

The capital stock (KN) is accumulated from investment flows (IN) using the perpetual inventory formula, with a depreciation rate of DEPNRAT percent (0 < DEPNRAT < 1).

$$KN=IN+(1-DEPNRAT)*KN(-1);$$

Labour demand (LLN) is the second part of the joint factor demand system. The effective input of labour is LLN * KTRNR^(DETANPH*ETANPH). This is equivalent to changing the labour-embodied technical progress term, LAMN.

log(LLN/ON) = -(DETANPH*ETANPH)*log(KTRNR)-log(ANX)- LAMN*TN
          + SIGN/(1-SIGN)*log(DELN)
          + SIGN/(1-SIGN) * log(
              (DELN/(1-DELN))^(-SIGN)*ERFPN^(SIGN-1) + 1.0) ;

6.6.3 Building and Construction Effects:

GDP in the BC-sector (OBC) is determined by total B&C-type investment (IBCTOT), real unit labour costs (ULCBC/PCONSC) and a time trend (TOBC). No NSRF-related spillover mechanisms are assumed for this sector. This is a reasonable and pragmatic assumption, since cohesion policy is implemented through this sector (or, at least, the physical infrastructure element of it), but the sector is not a direct beneficiary of output and productivity enhancing spillovers. Although this is an approximation, it is a prudent one to make.

The calibrated behavioural coefficients for the Turkish illustrative case are as follows:

AOBC1 = 3.52935 ;
AOBC2 = 0.536202 ;   {Fixed elasticity of OBC wrt IBCTOT}
AOBC3 = 0.0 ;   {Time varying elasticity of OBC wrt RULCBC}
AOBC4 = -0.000241540 ;   {Autonomous time trend}

And the full equation can be written:

log(OBC) = AOBC1+AOBC2*log(IBCTOT)+AOBC4*TOBC ;

As in the cases on the T and N sectors, 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 TBC is time.

The CES production function parameters (ABC, SIGBC, LAMBC and DELBC) are as follows, using the Turkish example:

ABC   =   3.43202   ; {Scale parameter}
SIGBC =   0.80000   ; {Elasticity of substitution: 0 < SIGBC < 1}
LAMBC =   0.0060048 ; {Rate of Hicks-neutral technical progress}
DELBC =   0.76113   ; {Weight for capital input}

Investment demand (IBC) is the first part of the two-equation joint factor demand system.

log(IBC/OBC) = -log(ABC) - LAMBC*TBC
            + SIGBC/(1-SIGBC)*log(1-DELBC)
            + SIGBC/(1-SIGBC) * log(
              (DELBC/(1-DELBC))^SIGBC*ERFPBC^(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 percent.

KBC=IBC+(1-DEPBCRAT)*KBC(-1);

Labour demand (LBC) is the second part of the two-equation joint factor demand system.

log(LBC/OBC) = -log(ABC)- LAMBC*TBC
            + SIGBC/(1-SIGBC)*log(DELBC)
            + SIGBC/(1-SIGBC) * log(
              (DELBC/(1-DELBC))^(-SIGBC)*ERFPBC^(SIGBC-1) + 1.0

6.6.4 Agriculture (A) Sector Effects:

Agricultural GDP (OA) is determined from a time-trended labour productivity relationship (TOA). Unlike the cases of T and N, no production function is imposed. The view is taken that low productivity in the A-sector is partially caused by under-employment. As investment and mechanisation grows, labour is "released" for work in the non-agriculture sectors, and productivity increases. In view of the under developed nature of the A sector, and since support for agriculture is only a minor part of modern EU cohesion policy, no spillover mechanism is included in this sector.

The calibrated behavioural coefficients for the Turkish illustrative case are as follows:

AOA1 = -0.026143 ;
AOA2 = 0.048713 ; {Trend "increase" in agricultural productivity}

log(OA/LA) = AOA1+AOA2*TOA ;

Numbers engaged in agriculture (employees and self employed) (LA) are modelled as an exponential time trend (TLA). This is designed to capture the structural change in the Turkish economy. But when projecting out to the future, care should be taken if the employment share is stabilizing.

ALA1 = 9.55801   ;
ALA2 = -0.039717 ;   {Trend "decline" in agricultural employment}

$$log(LA) = ALA1+ALA2*TLA;$$

The capital intensity of agricultural output (KA/OA) is modelled as an exponential time trend (TKA).

AKA1 = -0.050487 ;
AKA2 = 0.033729 ;   {Trend "increase" in capital intensity in agriculture}

$$log(KA/OA) = AKA1+AKA2*TKA ;$$

Agricultural investment (IA) is recovered by inverting the perpetual inventory formula used to define the capital stock (KA), where DEPA is the assumed depreciation rate.

$$IA =KA-(1-DEPA)*KA(-1) + TRIAEOT ;$$

Since a small element of direct aid to productive sectors is targeted at agriculture, this (TRIAEOT) is included as a boost to investment, but only as a transient effect during the implementation phase of the cohesion policy programme.

6.6.5 Non-market Services (G) Sector Effects:

The value of GDP arising in the G-sector (OGV) is measured mainly by wage inputs (YWG) but also includes a 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). For convenience, OGNW is treated as a policy instrument. Note that "overhead" costs of running the plan training programmes are included as an element of non-wage public consumption (but defaults to zero in the absence of any plan programme expenditure).

$$OGNWV=POG*OGNW + OVERHD*SFWAG ;$$

The G-sector wage bill (YWG) is the product of employment (LG) and the wage rate (WG). Training instructors are assumed to be in the YWG wage bill, and are paid at the rate WN. In the absence of ESF programme expenditure, this term defaults to zero.

$$YWG=LG*WG + LINS*WN ;$$

7. Conclusion

The objective of this paper has been to introduce and use the HERMIN modeling framework and methodology to construct, estimate and test a five-sector macro model of the Turkish economy at national level. Section 2 started with the discussion of the modeling database and with its help, the development process of the Turkish economy was illustrated by presenting some stylised facts that are considered important to this process and to the model structure.

Section 3 reviewed the theoretical background of the HERMIN model, with its neo-Keynesian and neo-classical features, and showed how it was suitable for analysing developing economies where sectoral shifts are at the centre of the development process.

Section 4 looked in detail on individual behavioural equations from the point of view of the calibration process. The functional forms of behavioural equations were discussed on the basis of the underlying theory and principles that guided us during the actual calibration of each of them, and the numerical values of the parameters obtained by this procedure were also considered. In several cases it was, therefore, necessary to simplify the original behavioural hypotheses either by dropping some of explanatory variables or by imposing additional constraints on the value of estimated parameters.

Section 5 discussed the implementation, validation and internal consistency of the model by means of within sample simulations and briefly described the process of fixing of intercepts for all of the behavioural equations of the model. Then, the model was tested by constructing an out-of-sample projection, in order to explore the likely evolution of the Turkish economy during the period 2007-2020. In doing so, the facts that 2007 and 2008 figures were realized during this study and the outlook of the world economy for 2009-2010 deteriorated dramatically along the way, were taken into account. Finally, several policy-oriented shocks to key exogenous variables were described. These experiments provide us with valuable policy feedback and also teach us about the propagation of the shocks throughout the model.

Following up on the previous discussion, the progress of development and subsequent integration into the EU is likely to entail both changes in the structural parameters of the economy, but also in the number and importance of mechanisms shaping its development. Since the successful completion of the transition to EU membership is likely to lead the economy on the path of real convergence, it is of great interest to examine these mechanisms and their mutual interdependence from the viewpoint of their impact on the macroeconomic development of the Turkish economy. Thus, the main task of this paper has been to present the model and explore its properties and uses.

Section 6 discussed how the model might be used to examine how public investment programmes like the EU Structural Funds is likely to affect the nature and speed of the development and convergence process in the context of the years during which Turkey will move towards membership of the EU. Further research on the model might be oriented towards the incorporation of a range of growth mechanisms into the model, and comparison of convergence profiles of the Turkish economy to other studies on this subject (e.g. Fisher, Sahay and Végh, 1996). The implementation of such mechanisms into the HERMIN model structure was based on the externality approach developed by Bradley et al. (1995a) in the context of impacts of the EU Structural Fund programmes on economic performance of several peripheral countries of the EU.

The new Turkish HERMIN model still has many "rough edges". For a model of its type – tightly structured with no ad-hoc elements – the calibration of the parameters was always going to be very difficult. However, as the body of empirical econometric literature expands in Turkey, its insights can be used to improve the selection of key parameter values. Two crucial areas will need this kind of research: the determination of manufacturing output and the determination of wage rates in manufacturing.

However, even with improved econometrics, the model provides only a stylised picture of the economy. It would be rewarding to learn more by:

i. Expanding the model in order to examine the important sub-components within manufacturing and market services[45],

ii. Modeling the agriculture sector in more detail, in order to move beyond the very simplistic "trend-based" approach,

iii. Implementing a more sophisticated model of consumer behaviour, that takes into account the fact that the evolution of the Turkish banking system now implies that the liquidity constraint on some Turkish consumers is no longer binding,

iv. Implementing a more detailed public sector block, where revenues and expenditure are modelled more realistically, and the debt financing issues are linked to a monetary sector,

v. Incorporating the monetary sector to attain a more realistic linkage between nominal and real aggregates as well as to account for the monetary transmission mechanisms that are in force.

Given that TURKSTAT started to announce national accounts data in 1998 constant prices after the first draft of the HERMIN Model for Turkey was completed, there is a need to reconstruct the model database and revisit the model parameters using the new national account data set[46].

More ambitiously, the model might possibly be extended towards the regional economies of Turkey and used to examine the serious regional development problems that must be tackled with the aid of large-scale public investment programmes. This will be a major challenge, but the regional versions of the HERMIN being used in Poland have already provided useful insights into these challenges[47].

Finally, the first version of the HERMIN Model for Turkey should be considered as an initial preparatory step for the evaluation of the impact of possible EU structural funds and building the technical capacity required for this process.

---

[45] For example, in the Irish model, manufacturing is further disaggregated into a foreign-owned high technology sector, a food processing sector, and a traditional (and mainly locally owned) sector. Services are disaggregated into transport and communications, wholesale and retail distribution, and a residual category that includes a wide range of professional and other services.

[46] However, we attach great value to the publication of this document, first because it presents a comprehensive account of the Hermin modeling framework, second because the Hermin Model for Turkey has been constructed and third because the model is already operational and can be used for medium term projections regarding the Turkish economy.

[47] See Bradley et al. (2008) for details of the Polish regional modelling experience.

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APPENDIX 1: Full listing of the HERMIN model

```
@ --------------------------------------------------------------------------
@
@               .-------------------------------------------.
@               !                                           !
@               !                   HTR5                    !
@               !                                           !
@               !   A HERMIN-TYPE FIVE-SECTOR MACRO MODEL   !
@               !           OF THE TURKISH ECONOMY          !
@               !                                           !
@               .-------------------------------------------.
@
@                     State Planning Organization
@                     Economic Modeling Department
@                       Necatibey Caddesi No.108
@                      06100 Yucetepe Ankara-TURKEY
@
@                   (Last modified: December 4, 2008)
@
@ --------------------------------------------------------------------------
@
@
@  (T)  : Manufacturing plus mining
@  (N)  : Market services and utilities
@  (BC) : Building & construction
@  (A)  : Agriculture sector - agriculture, forestry & fishing
@  (G)  : Public sector - public administration, health and education
@
@ ----------------------------------------------------------------------
@
@   Structural Fund dummy variables (see User Guide for definitions)
@
@   DETANPH   DETATPH   DETATQH
@   DETANPI   DETATPI   DETATQI
@
@   Behavioural equation -specific time trends are used so as to permit
@   the alteration of time trends out-of-sample:
@
@   (1) Manufacturing            : TOT (OT)    TT (JFD CES for T)
@   (2) Market services          : TON (ON)    TN (JFD CES for N)
@   (3) Building & construction : TOBC (OBC)  TBC (JFD CES for BC)
@   (4) Agriculture              : TOA (OA)    TLA (LA)    TKA (KA)
@   (5) Labour supply            : TLFPR (LFPR)
@ --------------------------------------------------------------------------
@
@ --------------------------------------------------------
@ -- The following parameters are imposed, not estimated --
@ -- and are used for the SF externality mechanisms      --
@ --------------------------------------------------------
@
@ ETA denotes an externality elasticity, with the following qualifiers

@   TQI : Manufacturing, prod comp ext due to infrastructure
@   TQH : Manufacturing, prod comp ext due to human capital

*P ETATQI  = 0.20;
*P ETATQH  = 0.20;

@   TPI : Manufacturing, lab productivity ext due to infrastructure
@   TPH : Manufacturing, lab productivity ext due to human capital

*P ETATPI  = 0.10;
*P ETATPH  = 0.10;

@   NPI : Market services, lab productivity ext due to infrastructure
@   NPH : Market services, lab productivity ext due to human capital
```

```
*P ETANPI  = 0.05;
*P ETANPH  = 0.05;

@ OVERHD is the training overhead (default set at 40 per cent
@ of wage expenditure)

*P OVERHD  = 0.40;

@ TMUP is the fraction of WT paid to trainees

*P TMUP    = 0.25;

@ TRATIO is the trainee/instructor ratio (default set at 20)

*P TRATIO  = 20;

@ -----------------------------------------------------------------------

@ Derivation of Convergence Priority and Cohesion Fund expenditure

@ Input EC total expenditure contribution for 2007-2013 in constant
@ 2005 euro as a datum (GECSFEC_RE), and convert to current euro (GECSFEC_E)
@ using an assumed 2% inflation rate from 2005.

@ T=21 in the year 2007

GECSFEC_E = GECSFEC_RE * 1.02^(T-21) ;

@ Convert GECSFEC_E to local currency using 2007 EUR exchange rate (TREUR07)

*P TREUR07 = 1.66953 ;

GECSFEC = GECSFEC_E * TREUR07 ;

@ Derive implied domestic (DP) co-finance contribution (GECSFDP), using
@ an assumed domestic co-finance ratio (RDCOFIN percent)

GECSFDP = (RDCOFIN/(100-RDCOFIN)) * GECSFEC;

@ Define total (EC+DP) expenditure (GECSF)

GECSF = GECSFEC + GECSFDP ;

@ Disaggregate into the three main economic categories.

@ Physical infrastructure (IGVCSFXX)
@ Human Resources (GTRSFXX), and
@ 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.

IGVCSFEC = (RIGVCSF/100) * GECSFEC ;
IGVCSFDP = (RIGVCSF/100) * GECSFDP ;

GTRSFEC  = (RGTRSF/100) * GECSFEC ;
GTRSFDP  = (RGTRSF/100) * GECSFDP ;

TRIEC = GECSFEC - (IGVCSFEC+GTRSFEC) ;
TRIDP = GECSFDP - (IGVCSFDP+GTRSFDP) ;

@ Disaggregate Direct Aid to the Productive Sector (TRIXX) into its
@ two sectoral allocations (manufacturing (T) and Market Services (N)
```

```
@ Manufacturing (Percentage share = RTRIT):

TRITEC = (RTRIT/100) * TRIEC ;
TRITDP = (RTRIT/100) * TRIDP ;

@ Market Services (residual):

TRINEC = TRIEC - TRITEC ;
TRINDP = TRIDP - TRITDP ;




@ -----------------------------------------------------------------------
@ -----------------------------------------------------------------------
@ ---------- PRODUCTION AND THE SUPPLY-SIDE IN HERMIN ----------------
@ -----------------------------------------------------------------------
@ -----------------------------------------------------------------------


@ ---------------------------------------------------------------
@ Definition of "world" demand (OW) and "world" price (PWORLD)
@ ---------------------------------------------------------------


@ --------------------
@ --- World demand (OW)
@ --------------------

@ OWXX is a trade-weighted measure of world activity in the model. There
@ are two such measures: OWIP and OWM).  OWIP is a trade-weighted measure of
@ industrial output.  OWM is a trade-weighted measure of imports.

@ An AMECO-based set of trading partner data is adopted for the model.
@ The export weights are given by (XW01-XW09), industrial production by
@ IPCTP1-IPCTP9, and imports by MCTP1-MCTP9.

@ See User Guide documentation for identification of Turkish trading
@ partners

@ Trade-weighted industrial output measure: OWIP (nine trading partners)

OWIP = exp( XW01*log(IPCTP1) + XW02*log(IPCTP2) + XW03*log(IPCTP3)
          + XW04*log(IPCTP4) + XW05*log(IPCTP5) + XW06*log(IPCTP6)
          + XW07*log(IPCTP7) + XW08*log(IPCTP8) + XW09*log(IPCTP9)  );

@ Trade-weighted imports measure: OWM (nine trading partners)

OWM =  exp( XW01*log(MCTP1) + XW02*log(MCTP2) + XW03*log(MCTP3)
          + XW04*log(MCTP4) + XW05*log(MCTP5) + XW06*log(MCTP6)
          + XW07*log(MCTP7) + XW08*log(MCTP8) + XW09*log(MCTP9)  );


@ ---------------------------------------------
@ --- World price (in local currency) (PWORLD)
@ ---------------------------------------------


@ The world price (PWORLD) and import price (PM) in local currency 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 industrial prices
@ (Germany, Italy, France, Spain, the Netherlands, Belgium)
@ -----------------------------------------------------------------------

@ The price index in EURO (PDE, PITA, etc.) is converted to Turkish currency
@ by multiplying by Turkish currency per EURO (TREUR).  Note the switch in
@ notation for Italy (PITA in place of PIT), since PIT is used elsewhere in the
@ model. Indices are base 2000=1.
```

```
PDE = (TREUR/57.48200)*(DEP/DEEUR);

PITA= (TREUR/57.48200)*(ITP/ITEUR);

PFR = (TREUR/57.48200)*(FRP/FREUR);

PES = (TREUR/57.48200)*(ESP/ESEUR);

PNL = (TREUR/57.48200)*(NLP/NLEUR);

PBE = (TREUR/57.48200)*(BEP/BEEUR);


@ Non-euro-zone wholesale prices
@ (UK, Sweden, USA)
@ ------------------------------------

@ The price index in sterling, Swedisk Kroner and US dollars (UKP, SEP and USP)
@ is converted to Turkish currency by multiplying by Turkish currency per unit
@ of foreign currency.  Indices are base 2000=1.


PUK = (TREUR/94.31318)*(UKP/UKEUR);

PSE = (TREUR/6.80647)*(SEP/SEEUR);

PUS = (TREUR/62.23690)*(USP/USEUR);


@ "World" manufacturing price (PWORLD) and national import price (PM)
@ ----------------------------------------------------------------------

@ The "world" manufacturing price for Turkey is an export-weighted set of
@ wholesale price indices, in the local currency.  The nine export weights
@ (XWP1 - XWP6) are re-normalised versions of the full set of export weights
@ (XWZZ in OWIP and OWM above)

PWORLD=exp( XWP1*log(PDE)+XWP2*log(PITA)+XWP3*log(PFR)+XWP4*log(PNL)
            +XWP5*log(PUK)+XWP6*log(PUS)  );

@ The import deflator is linked to import-weighted world prices, in local
@ currency.  This is only an approximation, so there are residuals. Note
@ switch in base to 1987=1

*A
PM = 827.08582 * exp(MWP1*log(PDE)+MWP2*log(PITA)+MWP3*log(PFR)+MWP4*log(PNL)
                    +MWP5*log(PUK)+MWP6*log(PUS) );


@ ----------------------------------------------------------------------
@ ----------             Manufacturing sector (T)        --------------
@ ----------------------------------------------------------------------


@ The weighted domestic demand measure reflects the output
@ content of a unit change in any of the components of domestic
@ demand.  The weights will be taken from the Turkish input/output
@ (sources & uses) table.

*P AIOTC = 1;
*P AIOTG = 1;
*P AIOTB = 1;
*P AIOTM = 1;

FDOT=AIOTC*CONS+AIOTG*RGENW+AIOTB*(IBCTOT+IH)+AIOTM*IMETOT ;
```

```
@ Manufacturing output is determined by "world" output,
@ the real cost of labour, weighted domestic demand, relative
@ domestic-to-world prices and a time trend. Improvements in
@ the stock of physical infrastructure and human capital relative
@ to a no-NDP baseline serve to increase manufacturing output
@ directly.

@ Elasticities on OW and FDOT constrained to add to unity.
@ Price/cost elasticities imposed.

@ Infrastructure and human capital externalities are included as
@ options in the determination of output (OT).

@ KGINFR = increase in stock of physical infrastructure relative
@          to baseline
@ KTRNR  = increase in stock of trained labour relative to baseline

@ Note that in the baseline simulation the ratios KGINFR and KTRNR
@ are set to unity.

*P AOT1   =   3.73174;
*P AOT2   =   0.325313;   {el(OT wrt OW) }
*P AOT3   =  -0.25;       {el(OT wrt RULCT) }
*P AOT4   =   0.674687;   {el(OT wrt FDOT)}
*P AOT5   =  -0.25;       {el(OT wrt PCOMPT) }
*P AOT6   =  0.00642302;  {autonomous growth}


*A
OT =  exp( AOT1+(DETATQI*ETATQI)*log(KGINFR)
                +(DETATQH*ETATQH)*log(KTRNR)
                +AOT2*log(OWM)
                +AOT3*log(ULCT/POT)
                +AOT4*log(FDOT)
                +AOT5*log(POT/PWORLD)
                +AOT6*TOT  );

@ The CES parameters that characterize manufacturing (T) are derived
@ by calibration to the data. SIGT imposed.

*P AT     = 5.44091;    {efficiency parameter }
*P SIGT   = 0.500000;   {elasticity of substitution}
*P LAMT   = 0.019206;   {Hicks neutral technical progress }
*P DELT   = 0.78423;

@ Only infrastructure has 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.

ATX=AT * (KGINFR)^(DETATPI*ETATPI) ;

@ 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; TT represents time.
@
@ ESRI Research Paper 115 (1984) gives derivations of the factor
@ demand equations (pp.309-312).  Technical progress is assumed to be
@ Hicks-neutral.

@ Investment demand (IT) is the first part of the joint factor demand system.

*A
IT = OT * exp( -log(ATX)
                + SIGT/(1-SIGT)*log(1-DELT)
                - LAMT*TT
                + SIGT/(1-SIGT) * log (
```

85

```
                         (DELT/(1-DELT))^SIGT*ERFPT^(1-SIGT)+1.0 )  )

                + TRITEOT ;

@ The next two equations permit one to make an exogenous boost (TRITEOT) to
@ T-sector investment. Three types of aid are included: EU (TRITEC), national
@ public counterpart
@ (TRITDP) and private sector (TRITPR).  No externalities are associated with
@ these direct aids.

TRIT=TRITEC+TRITDP ;

TRITEOT=(TRIT+TRITPR)/PIT ;

@ The capital stock is accumulated using the perpetual inventory
@ formula, assuming an rate of depreciation of DEPT equal to 5% pa

*P DEPT = 0.05;

KT=IT+(1-DEPT)*KT(-1) ;

@ Note two variants of equation for KT0.  The second permits the
@ definition of a baseline KT0 equal to the actual KT.  The first
@ permits one to exogenise KT0 in CSF-type simulations and set it
@ equal to this baseline value.

KT0=KT0;
KT0=KT;

@ KTR is the ratio of the post-shock to the pre-shock capital stock
@ in the T sector.

KTR=(KT/KT0) ;

@ The effective input of labour is
@
@               LT * KTRNR^(DETATPH*ETATPH),
@
@ where KTRNR is a training stock ratio dependent on training
@ expenditures.  This is equivalent to inserting a labour-embodied
@ technical progress term

*A
LT = OT  *  exp( -(DETATPH*ETATPH)*log(KTRNR)
                -log(ATX)
                + SIGT/(1-SIGT)*log(DELT)
                - LAMT*TT
                + SIGT/(1-SIGT) * log (
                      (DELT/(1-DELT))^(-SIGT)*ERFPT^(SIGT-1) + 1.0 ));

@ Split out employees and self-employed

LTSEMP = SETRAT*LT;
LTEMP = LT - LTSEMP;

@ The price of manufacturing output is determined by the "world"
@ price and by a mark-up on unit labour costs.  More open economies
@ tend to be price takers.  Free estimation suggested a lower value
@ for APOT2 (0.56).  A value of 0.7 was imposed.

*P APOT1  =  5.09887;
*P APOT2  =  0.7;    {el(POT wrt PWORLD) }

*A
POT = exp( APOT1+APOT2*log(PWORLD)+(1-APOT2)*log(ULCT) ) ;

POTDOT=100*(POT/POT(-1)-1);
```

@ Average annual earnings (WT) is driven by full indexation to
@ the output deflator (POT), a Philips curve term (URBAR)
@ and a partial pass-through of productivity (LPRT).

@ Calibrated over 1995-2006. Full pass-through of productivity
@ imposed. P-Curve imposed at -0.01. No tax wedge.

```
*P AWT1   = -1.30295;
*P AWT2   =  0.0000;    {el(WT wrt WEDGE): positive}
*P AWT3   = -0.01;      {semi-el(WT wrt URBAR)-Phillips term:negative }
*P AWT4   =  1.0;       {el(WT wrt LPRT) }

*A
WT = POT*exp( AWT1+AWT2*log(WEDGE)+AWT3*URBAR+AWT4*log(LPRT) );
```

@ Wage inflation in T-sector (WTDOT)

```
WTDOT=100*(WT/WT(-1)-1) ;
```

@ Labour productivity in T-sector

```
LPRT=OT/LT ;
```

@ Required real rate of return (RRSA). This is defined as the nominal long-term
@ interest rate (IRLT) corrected for inflation (POTDOT). Initially, RRSA is
@ exogenous RRSA=IRLT-POTDOT;

@ User cost of capital in T-sector

```
PKT = PIT*(DEPT+RRSA/100) ;
```

@ Relative price of labour to capital (RFPT)

```
RFPT=WT/PKT ;
```

@ Expectations for the relative factor price are backward-looking

```
ERFPT = (RFPT+0.75*RFPT(-1))/(1+0.75) ;
```

@ ULCT is the unit labour cost in the T-sector

```
ULCT=YWT/OT ;
```

@ Real unit labour costs in T-sector (RULCT)

```
RULCT = ULCT/POT ;
```

@ Price competitiveness measure for T-sector (PCOMPT)

```
PCOMPT = POT/PWORLD ;
```

@ Output of the T-sector in value (OTV)

```
OTV=POT*OT ;
```

@ Wage bill in T-sector

```
YWT=LTEMP*WT ;
```

@ Labour share of added-value (LSHRT)

```
LSHRT= 100 * YWT/OTV ;
```

@ Profits in T-sector (but no value of depreciation available)

```
YCT=OTV-YWT ;
```

```
@ -------------------------------------------------------------------------
@ ----              Market Services sector (N)                        ----
@ ----   Utilities, trade, transport, banking, communications, etc.   ----
@ -------------------------------------------------------------------------

@ The weighted domestic demand measure reflects the output content of a
@ unit change in any of the components of domestic demand.

@ The weights will be taken from the Turkish input/output (sources & uses) table.

*P AIONC = 1;
*P AIONG = 1;
*P AIONB = 1;
*P AIONM = 1;

FDON =AIONC*CONS+AIONG*RGENW+AIONB*(IBCTOT+IH)+AIONM*IMETOT ;

@ N-sector output (ON) is determined by weighted domestic
@ demand (FDON) and a time trend (TON) acting as a proxy for
@ N-sector autonomous expansion

*P AON1  = 5.03145;
*P AON2  = 0.472824;
*P AON3  = 0.027559;

*A
ON = exp( AON1 + AON2*log(FDON) + AON3*TON ) ;

@ Investment (IN) and labour demand (LLN) 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).
@ ERFPN is the expected relative factor price ratio and T is time.

@ The CES parameters that characterize market services (N) are
@ derived by calibration to the data.

*P AN      = 9.00056;     {efficiency parameter }
*P SIGN    = 0.58867;     {elasticity of substitution}
*P LAMN    = 0.0019795;   {Hicks neutral technical progress }
*P DELN    = 0.90225;

@ There is a total factor productivity externality, due to
@ infrastructure, as in the T-sector (see above).

ANX=AN*(KGINFR)^(DETANPI*ETANPI) ;

@ Investment demand (IN) is the first part of the joint factor demand system.

*A
IN =  ON * exp( -log(ANX)
                + SIGN/(1-SIGN)*log(1-DELN)
                - LAMN*TN
                + SIGN/(1-SIGN) * log(
                      (DELN/(1-DELN))^SIGN*ERFPN^(1-SIGN)+ 1.0 ) )

                + TRINEOT ;

@ The next two equations permit one to make an exogenous
@ boost (TRINEOT) to investment by the N-sector. Three types
@ of aid are included: EU (TRINEC), national public counter-part
@ (TRINDP) and private sector (TRINPR)

TRIN=TRINEC+TRINDP ;

TRINEOT=(TRIN+TRINPR)/PIN ;
```

```
@ The capital stock (KN) is accumulated from investment flows (IN) using the
@ perpetual inventory formula, with a depreciation rate of DEPN per cent.

*P  DEPN  = 0.03;

KN=IN+(1-DEPN)*KN(-1);

@ Note two variants of equation for KN0.  The second permits the
@ definition of a baseline KN0 equal to the actual KN.  The first
@ permits one to exogenise KN0 in CSF-type simulations.

KN0=KN0;
KN0=KN;

@ KNR defines the increase in the N-sector capital stock (KN)
@ relative to an ex-ante baseline (KN0)

KNR=(KN/KN0) ;

@ Labour demand (LLN) is the second part of the joint factor demand system.

@ The effective input of labour is  LLN * KTRNR^(DETANPH*ETANPH).
@ This is equivalent to inserting a labour-embodied technical
@ progress term

*A
LLN = ON  *  exp( -(DETANPH*ETANPH)*log(KTRNR)
                 -log(ANX)
                 + SIGN/(1-SIGN)*log(DELN)
                 - LAMN*TN
                 + SIGN/(1-SIGN) * log(
                     (DELN/(1-DELN))^(-SIGN)*ERFPN^(SIGN-1) + 1.0 ))  ;

@ Split out employees and self-employed

LLNSEMP = SENRAT*LLN;
LLNEMP = LLN - LLNSEMP;

@ PON defines an N-sector output price deflator, determined as
@ a mark-up on unit labour costs.

*P APON1   = 1.97307;
*P APON2   = 0.605170;

*A
PON = exp( APON1+APON2*log(ULCN)+(1-APON2)*log(ULCN(-1)) );

@ Labour productivity in N-sector

LPRN=ON/LLN ;

@ The "Scandinavian" model assumption of homogeneous labour markets
@ is invoked to equate WNDOT to WTDOT

*A
WN = WN(-1) * (WT/WT(-1)) ;

@ Wage inflation in the N-sector (WNDOT)

WNDOT=100*(WN/WN(-1)-1) ;

@ The cost of capital, PKN, is determined by the investment
@ price and a modified real interest rate

PKN=PIN*(DEPN+RRSA/100) ;

@ Relative price of labour to capital (RFPN)
```

```
RFPN=WN/PKN ;

@ Expectations of relative factor prices are backward-looking

ERFPN = (RFPN+0.75*RFPN(-1))/(1+0.75) ;

@ Unit labour costs in the N-sector (ULCN)

ULCN=YWN/ON ;

@ The value of N-sector output is determined by an identify
@ as the product of the price and volume

ONV=PON*ON ;

@ Wage bill in the N-sector (YWN)

YWN=LLNEMP*WN ;

@ Labour share of added-value in the N-sector (LSHRN)

LSHRN=100*YWN/ONV ;

@ Profits in the N-sector (YCN)

YCN=ONV-YWN ;



@ ---------------------------------------------------------------------
@ ----------    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 =   3.52935;
*P AOBC2 =   0.536202;
*P AOBC3 =   0.0000;
*P AOBC4 =  -0.000241540;

*A
OBC = exp( AOBC1+AOBC2*log(IBCTOT)+AOBC3*log(ULCBC/PCONS)+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.

@ The CES parameters that characterize BC are derived by data calibration

*P ABC   =   3.43202;      {efficiency parameter }
*P SIGBC =   0.80000;      {elasticity of substitution}
*P LAMBC =   0.0060048;     {Hicks neutral technical progress }
*P DELBC =   0.76113;

@ Investment demand (IBC) is the first part of the joint factor demand system.

*A
IBC =  OBC * exp( -log(ABC)
                + SIGBC/(1-SIGBC)*log(1-DELBC)
                - LAMBC*TBC
                + SIGBC/(1-SIGBC) * log(
                      (DELBC/(1-DELBC))^SIGBC*ERFPBC^(1-SIGBC)+ 1.0 ) ) ;


@ The capital stock (KBC) is accumulated from investment flows (IBC) using the
```

@ perpetual inventory formula, with a depreciation rate of DEPBC per cent.

*P DEPBC = 0.03;

KBC=IBC+(1-DEPBC)*KBC(-1);

@ Labour demand (LBC) is the second part of the joint factor demand system.

*A
LBC = OBC * exp(-log(ABC)
                  + SIGBC/(1-SIGBC)*log(DELBC)
                  - LAMBC*TBC
                  + SIGBC/(1-SIGBC) * log(
                      (DELBC/(1-DELBC))^(-SIGBC)*ERFPBC^(SIGBC-1) + 1.0)) ;

@ Split out employees and self-employed

LBCSEMP = SEBCRAT*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 APOBC1 = 0.857029 ;
*P APOBC2 = 0.846369 ;

*A
POBC = exp(APOBC1+APOBC2*log(ULCBC)+(1-APOBC2)*log(ULCBC(-1)));

@ Labour productivity (LRPBC) is defined as the ratio of output (OBC) to
@ employment (LBC).

LPRBC=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 services (WN/WN(-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.

*A
WBC = WBC(-1) * (WN/WN(-1)) ;

@ The annual inflation rate (WBCDOT) is defined.

WBCDOT=100*(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*(DEPBC + RRSA/100);

@ RFPBC is the relative factor price (labour (WBC) to capital (PKBC))
@ to the cost of capital (PKBC).

RFPBC=WBC/PKBC;

@ Expectations of relative factor prices (ERFPBC) are formed by a simple
@ one-period backward-looking moving average.

ERFPBC = (RFPBC+0.75*RFPBC(-1))/(1+0.75);

@ Unit labour cost (ULCBC) is derived from the wage bill (YWBC) divided
@ by real output (OBC)

ULCBC=YWBC/OBC;

```
@ The value of BC-sector GDP (OBCV) is determined as the product of the
@ price (POBC) and real output (OBC).

OBCV=POBC*OBC ;

@ The BC-sector wage bill (YWBC) is the product of numbers employed
@ (LBC) and the wage rate (WBC).

YWBC=LBCEMP*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).

LSHRBC=100*YWBC/OBCV;

@ Profits in the BC-sector (YCBC) are derived by subtracting the wage bill
@ (YWBC) from the value of BC-sector GDP (OBCV)

YCBC=OBCV-YWBC;




@ ----------------------------------------------------
@ -------   Agricultural Sector (A)      ------------
@ ----------------------------------------------------

@ Output, employment and the capital/output
@ ratio are modelled as time trends.

@ OA/LA is calibrated over post 1996 period.

*P AOA1 =  -0.026143;
*P AOA2 =   0.048713;   {trend rise in productivity in A }

*A
OA = LA * exp( AOA1+AOA2*TOA );

@ LA is calibrated over post 1996 period.

*P ALA1  =  9.55801;
*P ALA2  = -0.039717; {trend decline in LA }

*A
LA = exp( ALA1+ALA2*TLA ) ;

@ Split out employees and self-employed

LASEMP = SEARAT*LA;
LAEMP = LA - LASEMP;

*P AKA1 =  -0.050487;
*P AKA2 =   0.033729;   {trend growth in KA/OA }

*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 ;

@ Investment (IA) is derived from the perpetual inventory
@ stock accumulation formula (KA), assuming a depreciation rate
@ of DEPA
```

```
*P DEPA = 0.025;

IA =KA-(1-DEPA)*KA(-1)+TRIAEOT ;

@ The value of output in the A-sector (OAV)

OAV=POA*OA ;

@ The "Scandinavian" model assumption of homogeneous labour markets
@ is invoked to equate WADOT to WTDOT

*A
WA = WA(-1) * (WT/WT(-1)) ;

@ Wage inflation in the A-sector (WADOT)

WADOT=100*(WA/WA(-1)-1) ;

YWA=LAEMP*WA;

@ Non-wage (profit) element in A-sector

YCA=OAV-YWA;




@ -------------------------------------------------------
@ -------- Non-Market Services sector equations --------
@ --------  (public sector, health, education)  --------
@ -------------------------------------------------------

@ Real non-market sector added-value is effectively measured
@ by employment inputs

OGV = YWG + OGNWV ;

@ Non-wage element of training scheme expenditure
@ (OVERHD*SFWAG) is added to non-wage element of OGV

OGNWV=POG*OGNW + OVERHD*SFWAG ;

OG = OGV/POG ;

@ The "Scandinavian" model assumption of homogeneous labour
@ markets is invoked to equate WGDOT to WTDOT

*A
WG = WG(-1) * (WT/WT(-1)) ;

@ The deflator of OGV is taken as the public sector wage rate

*A
POG = POG(-1) * (WG/WG(-1)) ;

@ Training instructors are assumed to be in YWG wage bill

YWG=LG*WG + LINS*WN ;


@ ----------------------------------------------------------------
@ ------   Labour supply, employment and unemployment   ---------
@ ----------------------------------------------------------------

@ Population is made exogenous in this version of the model

@ N     = Total population
@ NWORK = Working age population
```

```
@ NELD  = retired population

@ The youth dependent population (NJUV) is computed residually.

NJUV = N-(NELD+NWORK);

@ The dependent population (NDEP) is defined as the sum of
@ NJUV and NELD

NDEP=NJUV+NELD;

@ The labour force participation rate (LFPR) can be
@ determined by the unemployment rate (UR(-1)) - the
@ discouraged worker effect and a time trend (TLFPR).
@ For the present it is modelled as a time trend.

*P ALFPR1 =  59.0258;
*P ALFPR2 = -0.579346;   {trend annual change in LFPR }

*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).  TFRACT measures the extent to
@ which trainees on pre-accession schemes are in or out
@ of the measured labour force.

LF = (LFPR/100)*(NWORK+NELD) - TFRACT*SFTRAIN ;

@ Private non-agricultural employment (LPNA)

LPNA=LT+LBC+LLN ;

@ Non-agricultural employment (LNA).  Note that the LINS
@ instructors/teachers, employed to service pre-accession
@ training schemes, are added to total employment.

LNA = LPNA+(LG+LINS) ;

@ Total employment (L) is the summation of numbers employed
@ in the four sectors T, N, 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 training scheme 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 trainees is fully reflected in URP.

URP=100*( (LFPR/100)*(NWORK+NELD)-TFRACT*SFTRAIN - L )
                     /( (LFPR/100)*(NWORK+NELD)-TFRACT*SFTRAIN);
```

```
@ URBAR defines a moving average unemployment rate for use only in the
@ Phillips curve of the T-sector wage equation

URBAR = (URP+URP(-1))/2 ;

@ The real after-tax average annual earnings in manufacturing
@ (RATWT) is defined as the nominal wage (WT) corrected for the
@ implicit average rate of direct taxation (RGTY), and deflated
@ by the consumption price (PCONS).

RATWT=WT*(1-RGTYP-RGTYSOCW)/PCONS;

@ Economy-wide (GDPFC) rate of labour productivity (LPROD)

LPROD=GDPFC/L ;

@ Economy-wide rate of labour productivity growth (LPRODDOT)

LPRODDOT=100*(LPROD/LPROD(-1)-1) ;




@ --------------------------------------------------------------------
@ --------------------------------------------------------------------
@ ----------- Absorption and the demand side of HERMIN ---------------
@ --------------------------------------------------------------------
@ --------------------------------------------------------------------


@ -------------------------------------------------------
@ ------------- Private consumption (CONS) -------------
@ -------------------------------------------------------

@ Private consumption expenditure in modelled as a liquidity
@ constrained model (CONS).  Lags can be used to dampen the
@ Keynesian multiplier.

*P ACONS1  = -915.631;
*P ACONS2  = 0.846825;  {impact MPC }

*A
CONS = ACONS1+ACONS2*YRPERD ;

CONSV = PCONS * CONS ;

@ Personal nominal savings (SAV)

SAV=YPERD-CONSV ;

@ Personal savings ratio (SAVRAT)

SAVRAT = 100*SAV/YPERD ;

@ ----------------------------------------------------
@ ------------- Public consumption (G) -------------
@ ----------------------------------------------------

@ Public consumption has a wage (YWG) and non-wage (GENW) element (GV)

GV=YWG+GENW ;

G=(YWG+GENW)/PG ;

@ Basic non-wage public consumption is kept fixed in real terms.
@ The overhead element in training programmes (OVERHD*SFWAG)
@ is counted as part of GENW (see OGNWV earlier)

GENW=PG*RGENW + OVERHD*SFWAG;
```

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```
@ ----------------------------------------
@ ------------- Investment (I) -------------
@ ----------------------------------------

@ Total investment by private sector (IP)

IP = IT+IBC+IN+IA ;

IPV = ITV+IBCV+INV+IAV ;

@ Private capital stock (KP), generated on sectoral basis

KP = KT+KBC+KN+KA;

@ Total public sector fixed investment (including any EU-type
@ programme elements)

IG = (IGV+IGVCSF) / PIG;

@ Sectoral investment in value (determined on supply-side in
@ factor demand equations).

ITV = PIT * IT;

IBCV = PIBC * IBC;

INV = PIN * IN;

IAV = PIA * IA;

@ Total fixed investment in current prices (IV)

IV=IPV+(IGV+IGVCSF)+IHV;

@ Total fixed investment

I=IP+IG+IH ;

@ Deflator of Total Investment

PI=IV/I;

@ Both public and private sector fixed investment (IG and IP)
@ are disaggregated into building and construction (B&C) and
@ machinery and equipment (M&E), a breakdown that is essential
@ for the correct modelling of weighted final demand measures
@ such as FDOT and FDON.

@ The B&C element has a much greater domestic output content
@ than for M&E, which is largely imported.
@
@ A variable fraction WIGME of public investment is assumed to
@ consist of M&E.

IGINFME = WIGME * IGINF;

@ The B&C element of IGINF is calculated residually (IGINFBC)

IGINFBC = IGINF - IGINFME;

@ The private non-housing investment is calculated (IOTH)

INH=I-IH;

IOTH=INH-IGINF;

@ A variable fraction WIOME of private investment is assumed to
```

```
@ consist of M&E.

IOTHME = WIOME * IOTH;

@ The B&C element of IGINF is calculated residually (IGINFBC)

IOTHBC = IOTH - IOTHME;

@ We now have total investment broken down by B&C (IBCTOT)
@ and M&E (IMETOT)

IBCTOT = IGINFBC + IOTHBC;

IMETOT = IGINFME + IOTHME;




@ -----------------------------------------------
@ ------------- Total imports (M) -------------
@ -----------------------------------------------

@ A simple total import demand equation is specified, where
@ total imports (M) are determined by final demand (FD), a
@ relative price term (PM/POT), and a time trend (T).
@ The import price deflator (PM) is expressed @ in local currency

*P AM1 = -2.00224 ;
*P AM2 =  1.0 ;          { el(M wrt FD) }
*P AM3 = -0.252620 ;    { el(M wrt PM/POT) }
*P AM4 =  0.047439  ;    { trend term }

*A
M = exp(AM1+AM2*log(FD)+AM3*log(PM/POT)+AM4*TM);

@ The value of total imports (MGV)

MV = PM*M;

@ -----------------------------------------------
@ ------------- Total exports (X) -------------
@ -----------------------------------------------

@ A simple total export demand equation is specified, where
@ total exports (X) are determined by manufacturing output (OT),
@ real unit labour costs (ULCT/POT), and a time trend (T)

*P AX1 =  -0.923477;
*P AX2 =  1.0000 ;       { el(X wrt OT) }
*P AX3 = -0.292843;     { el(X wrt ULCT/POT) }
*P AX4 =  0.054950;     { trend term }

*A
X = exp(AX1+AX2*log(OT)+AX3*log(ULCT/POT)+AX4*TX);

@ The value of total exports (XV)

XV = PX*X;

@ The net trade surplus is determined as (X-M)

NTSV = XV - MV;

NTS  = X - M;


@ -----------------------------------------------
@ ------------- Stock changes (DS) -------------
@ -----------------------------------------------
```

```
@ Stock changes (DS) are modelled as a residual from the GDP identies
@ for output (GDPM) and expenditure (GDPE)

DSV = GDPMV - (CONSV+GV+IV+XV-MV);

DS  = GDPM - (CONS+G+I+X-M);

@ Stock levels (ST)

ST=DS+ST(-1);




@ -----------------------------------------------------------
@ ----- National expenditure and demand identities --------
@ -----------------------------------------------------------

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 CSF-type simulations.

GDPEV0=GDPEV0;
GDPEV0=GDPEV;

GDPE=CONS+I+G+DS+NTS;

GDPEDOT=100*(GDPE/GDPE(-1)-1);

PGDPE=GDPEV/GDPE;

@ Net trade surplus as percentage of GDPEV

NTSVR = 100*NTSV/GDPEV;

@ Domestic absorption (GDA)

GDA = CONS+G+I+DS;

@ (Restricted) final demand (FD)

FD = CONS+G+I+X;


@ -------------------------------------
@ --- 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).

@ Price of aggregate fixed investment (PIAGG). Note that PIAGG is an
@ artificial variable (set equal to PI historically) and used as a
@ common price for PIT, PIN, PIBC, PIA and PIG.  Having determined
@ these prices, PI is determined in the identity PI=IV/I.

*P API1  =   -0.112426;
*P API2  =    0.574136;    {el(PI wrt PGDPFC) }


*A
PIAGG = exp( API1+API2*log(PGDPFC)+(1-API2)*log(PM) );

@ The deflators PIT, PIN, PIA and PIG are linked to PI via their
@ inflation rates
```

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```
PIT = PIT(-1)*(PIAGG/PIAGG(-1));

PIBC = PIBC(-1)*(PIAGG/PIAGG(-1));

PIN = PIN(-1)*(PIAGG/PIAGG(-1));

PIA = PIA(-1)*(PIAGG/PIAGG(-1));

PIG = PIG(-1)*(PIAGG/PIAGG(-1));

@ Deflator of private consumption (PCONS).  Note that all net
@ indirect taxes (RGTE) are assumed to be imposed on private
@ consumption.

*P APC1 =  -0.076196;
*P APC2 =   0.847433;   {el(PCONS wrt PGDPFC) }
*P APC3 =   1.0000;     {semi-elasticity of PCONS wrt TINC}

*A
PCONS = exp( APC1+APC2*log(PGDPFC)+(1-APC2)*log(PM)+APC3*RGTE );

PCONSDOT=100*(PCONS/PCONS(-1)-1);

@ Price of exports (PX).  Impose high elasticity on PWORLD (0.8)

*P APX1  =  5.20704;
*P APX2  =  0.2;          {el(PX wrt PGDPFC) }

*A
PX = exp( APX1+APX2*log(PGDPFC)+(1-APX2)*log(PWORLD) );

PXDOT=100*(PX/PX(-1)-1);

@ Deflator of public consumption is linked to output price (POG)

*A
PG = PG(-1)*(POG/POG(-1));

@ Rate of inflation of the GDP deflator (PGDPFCDT)

PGDPFCDT=100*(PGDPFC/PGDPFC(-1)-1);

@ Private non-agricultural output deflator (POPNA)

POPNA = (POT*OT+POBC*OBC+PON*ON)/(OT+OBC+ON);

@ Private non-agricultural output price inflation (POPNADOT)

POPNADOT = 100*(POPNA/POPNA(-1)-1);




@ ------------------------------------------------------------------
@ ------- Income distribution (public sector) --------
@ ------------------------------------------------------------------


@ ----------------------------------------------------
@ -----  Public sector (revenue and expenditure) ------
@ ----------------------------------------------------

@ ---------- Revenue --------------------

@ ----------------
@ --- Direct taxes
@ ----------------
```

```
@ Revenue from direct taxes (GTYP). The implicit rate (RGTYP)
@ can be endogenised through a policy feed-back rule.  It is
@ currently set exogenously (RGTYEX).

GTYP = RGTYP*YW;

RGTYP = RGTYPEX ;

@ Total revenue from social insurance contributions (GTYSOC)

GTYSOC = GTYSOCE+GTYSOCW;

@ Employers' social insurance contributions (GTYSOCE)

GTYSOCE=RGTYSOCE*YW;

@ Employees' social insurance contributions (GTYSOCW)

GTYSOCW=RGTYSOCW*YW;

@ Corporate tax revenue (GTYC)

GTYC=RGTYC*YC(-1);

@ Wealth taxes (GTYW)

GTYW = RGTYW*GDPFCV;

@ Total direct tax revenue (GTY)

GTY = GTYP+GTYSOC+GTYC+GTYW;

@ ------------------
@ --- Indirect taxes
@ ------------------

@ Revenue from VAT (GTEVAT)

GTEVAT = RGTEVAT*CONSV;

@ Revenue from excise duties (GTEX)

GTEX = RGTEX*CONS;

@ Revenue from import taxes (GTEM)

GTEM = RGTEM*MV;

@ Other indirect tax revenue (GTEO)

GTEO = RGTEO*GDPFCV;

@ Total indirect tax revenue (GTE)

GTE = GTEVAT+GTEX+GTEM+GTEO;

@ Aggregate indirect tax rate (assumed levied on GDPFCV)

RGTE=GTE/GDPFCV;

@ Total tax revenue (GREVTAX)

GREVTAX = GTY+GTE;

@ Other (non-tax) revenue (GREVO)

GREVO = RGREVO*GDPFCV;
```

@ The variable CSFTRAN represents the total EU injection of
@ Structural fund-type aid (training, infrastructural and other).

CSFTRAN=(GTRSFEC+IGVCSFEC+TRITEC+TRINEC+TRIAEC);

@ The variable CSFTRANR represents the total EU structural fund
@ type aid as a percentage of GDPMV.

CSFTRANR=100*(CSFTRAN/GDPMV);

@ From a public accounts viewpoint, the EU structural fund-type
@ aid is represented as a capital inflow from abroad (CSFTRAN
@ feeding into GREV).

@ Total public sector revenue

GREV = GREVTAX+GREVO + CSFTRAN;

@ Total tax "wedge" (for possible use in wage equation

WEDGE=(1+RGTYP+RGTYSOCW)*(1+RGTE);

@ ---
@ ---------- Public expenditure -----------
@ ---

@ Current expenditure on goods and services (GV_GFS) has a wage (YWG_GFS)
@ and non-wage (GENW_GFS) component and these components evolve according to
@ the growth rate of YWG and GENW

YWG_GFS=YWG_GFS(-1)*(YWG/YWG(-1));

GENW_GFS=GENW_GFS(-1)*(GENW/GENW(-1));

GV_GFS = YWG_GFS+GENW_GFS;

@ -----------------------
@ Expenditure on transfers
@ -----------------------

@ Interest payments on the national debt (GTRNDI)

GTRNDI = RGTRNDI*GND;

@ Social welfare payments (assumed to be indexed) (GTRSOCW)

GTRSOCW = RGTRSOCW*(N*PCONS);

@ Social Insurance Fund deficit (GTRSOCDF) equals revenue less expenditure

GTRSOCDF = GTRSOCW - GTYSOC;

@ Unemployment income support transfers (GTRU)

GTRU = RGTRU*U ;

@ The average rate of unemployment transfer (RGTRU) is indexed to annual price
@ inflation

*A
RGTRU = RGTRU(-1) * (PCONS/PCONS(-1)) ;

@ Other domestic transfer payments (GTRO)

GTRO = RGTRO*(PCONS*N);

```
@ Trasnsfer payments to agriculture (GTRA)

GTRA = RGTRA*OAV;


@ The injection of EU funding for training (GTRSFEC) is
@ accompanied by a national public sector counterpart (GTRSFDP)
@ as well as a national private sector counterpart (GTRSFPR)

GTRSF=GTRSFEC+GTRSFDP+GTRSFPR;

@ Total (EU+Domestic) CSF 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).
@ Thus,
@
@        GTRSF = (SFTRAIN*WTRAIN+LINS*WN)*(1+OVERHD)
@
@ and this identity is solved for SFTRAIN below.

SFTRAIN = (GTRSF/(1.0+OVERHD)) / (WTRAIN+WN/TRATIO);

@ The wage element of the EU training expenditures is defined
@ as SFWAG.

SFWAG=SFTRAIN*WTRAIN+LINS*WN;

@ The number of instructors to be employed is related to
@ the number of new trainees (SFTRAIN), assuming a
@ trainee/instructor ratio of TRATIO.

LINS = SFTRAIN/TRATIO;

@ The average annual payment to a trainee is assumed to be
@ 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  = 4  ;
*P YNUT = 2  ;
*P YUT  = 4  ;

*P FPLS = 0.54 ;
*P FHS  = 0.31 ;
*P FNUT = 0.03 ;
*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;

KTRAIN0=KTRAIN0;
KTRAIN0=KTRAIN;

@ 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 EU-funded training schemes.
@ Positive externalities are associated with increases in
@ this ratio relative to an ex-ante baseline (KTRAINO).

KTRNR=(KTRAIN0+KSFTRAIN)/KTRAIN0;

@ Total transfer payments (GTR)

GTR = GTRNDI+GTRSOCW+GTRU+GTRO+GTRA + SFTRAIN*WTRAIN ;

@ 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-EU (IGV) and the purely EU expenditures (IGVCSF).

IGINFV=IGV+IGVCSF;

IGINF = IGINFV/PIG;

@ Infrastructural investment is accumulated into a notional
@ stock (KGINF) by a perpetual inventory formula, assuming
@ a DEPG per cent depreciation rate.

*P DEPG = 0.02;

KGINF = IGINF + (1-DEPG)*KGINF(-1);

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);

@ Public capital expenditure includes both domestic and
@ EU-financed elements of the EU infrastructural projects and
@ capital transfers to private sector as production/investment aids.
@ It also includes capital transfers (GTRK).

GEK=(IGINFV-IGVCSFPR)+(TRIT+TRIN+TRIA)+GTRK ;

@ Total expenditure on the EU projects (EC, DP and PR) is GECSFT

GECSFT=IGVCSF+GTRSF+(TRIT+TRITPR)+(TRIN+TRINPR)+(TRIA+TRIAPR);

@ Expenditure on the EU projects (EC, DP) is GECSFP

GECSFP=(IGVCSFEC+IGVCSFDP)+(GTRSFEC+GTRSFDP)+(TRIT+TRIN+TRIA) ;

@ Expenditure on the EU projects (EC) is GECSFE

GECSFE=IGVCSFEC+GTRSFEC+(TRITEC+TRINEC+TRIAEC) ;

@ 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);

@ Total public sector current expenditure (GEC).  Note that we use
@ the GFS definitions of wage and non-wage expenditure.

GEXPC = GV_GFS+GTR;

@ Total public sector expenditure (current and capital)

GEXP = GEXPC + GEK;

@ Public sector total borrowing requirement (GBOR)

GBOR = GEXP - GREV;

@ Public sector borrowing requirement as percentage of
@ GDPEV (GBORR)

GBORR = 100*GBOR/GDPEV;

@ A simple process of national debt accumulation
@ is modelled. There is an exogenous and endogenous
@ option, depending on the value of DUMGND:

@ DUMGND = 1 implies that GND is exogenous
@ DUMGND = 0 implies that GND is endogenous

GND = DUMGND*GNDEX + (1-DUMGND) *( GND(-1)+GBOR ) ;

@ The debt/GDP ratio (RDEBT) is a memo item, but can
@ be used to influence the intertemporal fiscal closure rule

RDEBT=100*GND/GDPEV;


@ -----------------------------------------------------
@ ------- Private income determination ---------------
@ -----------------------------------------------------

@ The key definition of gross domestic product at factor
@ cost aggregates the four sectoral added-value measures

GDPFCV=OTV+OBCV+ONV+OAV+OGV;

GDPFC = OT+OBC+ON+OA+OG;

GDPFCDOT=100*(GDPFC/GDPFC(-1)-1);
```

```
PGDPFC=GDPFCV/GDPFC;

@ GDP at market prices

GDPMV=GDPFCV+STATDISV;

GDPM=GDPFC+STATDIS;

GDPMDOT=100*(GDPM/GDPM(-1)-1);

PGDPM=GDPMV/GDPM;

@ ----------------------------------------------
@ Definition of personal disposable income (YRPERD)
@ ----------------------------------------------

@ Total depreciation (DEPRT) is linked to the value of the capital stock,
@ PI*(KT+KN+KA)

DEPRT = DEPRAT*(PI*(KT+KBC+KN+KA)) ;

@ Net domestic product at factor cost (NDPFCV)

NDPFCV = GDPMV-DEPRT-GTE;

@ Net national product at factor cost (NNPFCV)

NNPFCV = NDPFCV+YFN;

@ Private sector income (YP)

YP = NNPFCV-GTTI+GTR+(SFTRAIN*WTRAIN);

@ Total wage bill in the economy (YW)

YW=YWT+YWBC+YWN+YWA+YWG;

@ Corporate profits (YC)

YC = NDPFCV-YW;

@ Undistributed (or retained) profits (YCU)

YCU=YCURAT*YC;

@ Personal sector income (YPER)

YPER = YP-YCU;

@ Personal disposable income (YPERD).  Net out employers
@ social contributions (GTYSOCE)

YPERD = YPER-(GTYP+GTYSOCW);

@ Real personal disposable income (YRPERD)

YRPERD=YPERD/PCONS;

@ Real per-capita personal disposable income (YRPERDPC)

YRPERDPC = YRPERD/N;

@ -----------------------
@ Miscellaneous identities
@ -----------------------

@ Non-agricultural sector wage bill (YWNA)
```

```
YWNA=YWT+YWBC+YWN+YWG;

@ Average annual earnings in non-agricultural sector (WNA)

WNA=YWNA/(LTEMP+LBCEMP+LLNEMP+LG);

WNADOT=100*(WNA/WNA(-1)-1);

@ Per capita GDP at factor cost (GDPFCPC)

GDPFCPC=GDPFC/N;

@ Non-agricultural output

ONA = OT+OBC+ON+OG;

@ Total private non-agricultural wage bill (YWPNA)

YWPNA = YWT+YWBC+YWN;

@ Average annual earnings in private non-agricultural sector (WPNA)

WPNA = YWPNA/(LTEMP+LBCEMP+LLNEMP);

@ Real private non-agricultural wage rate (RWPNA)

RWPNA = WPNA/PCONS;

RWPNADOT=100*(RWPNA/RWPNA(-1)-1);

@ Unit labour costs in private non-agricultural sector (T plus N)

ULCPNA = (YWT+YWBC+YWN)/(OT+OBC+ON);

@ Productivity in private non-agricultural sector (T plus N)

LPRPNA = (OT+OBC+ON)/(LT+LBC+LLN) ;
```

APPENDIX 2: Master dictionary of model variables

Exogenous variables in Standard HERMIN country model

[B] Basic input - AMECO	
[B] Basic input - other source	
[GZ or GI] Generate & initialise	
[G] Generate	

Name	Type	Description	Comment
	Basic **G**enerated		
BEIP	B	Belgium: Industrial production (index)	AMECO
BEM	B	Belgium: Total imports (index)	AMECO
BEP	B	Belgium: Wholesale prices (index)	AMECO
BGIP	B	Bulgaria: Industrial production (index)	AMECO
BGM	B	Bulgaria: Total imports (index)	AMECO
BPRES	B	BOP item: residual	
BPTPRNE	B	BOP item: private sector transfers	
BRIP	B	Brazil: Industrial production (index)	AMECO
BRM	B	Brazil: Total imports (index)	AMECO
CAIP	B	Canada: Industrial production (index)	AMECO
CAM	B	Canada: Total imports (index)	AMECO
CHIP	B	Switzerland: Industrial production (index)	AMECO
CHM	B	Switzerland: Total imports (index)	AMECO
CNIP	B	China: Industrial production (index)	AMECO
CNM	B	China: Total imports (index)	AMECO
CYIP	B	Cyprus: Industrial production (index)	AMECO
CYM	B	Cyprus: Total imports (index)	AMECO
CZIP	B	Czech Republic: Industrial production (index)	AMECO
CZM	B	Czech Republic: Total imports (index)	AMECO
DEIP	B	Germany: Industrial production (index)	AMECO
DEM	B	Germany: Total imports (index)	AMECO
DEP	B	Germany: Wholesale prices (index)	AMECO
DEPARAT	GI	Depreciation rate: agriculture	Set to 0.025
DEPBRAT	GI	Depreciation rate: building & construction	Set to 0.05
DEPMRAT	GI	Depreciation rate: market services	Set to 0.05
DEPRAT	G	Depreciation rate: whole economy (implicit)	DEPV = DEPRAT*(PI*(KT+KM+KB+KA +KGINF))
DEPTRAT	GI	Depreciation rate: manufacturing	Set to 0.08
DETANPH	GZ	Spillover phase-in: Sector N / Type PH	Set to zero
DETANPI	GZ	Spillover phase-in: Sector N / Type PI	Set to zero
DETATPH	GZ	Spillover phase-in: Sector T / Type PH	Set to zero
DETATPI	GZ	Spillover phase-in: Sector T / Type PI	Set to zero
DETATQH	GZ	Spillover phase-in: Sector T / Type QH	Set to zero
DETATQI	GZ	Spillover phase-in: Sector T / Type QI	Set to zero
DUMGND	GI	Dummy variable for GND (exogenous/endogenous)	Set to unity (default)
EEIP	B	Estonia: Industrial production (index)	AMECO
EEM	B	Estonia: Total imports (index)	AMECO
ELIP	B	Greece: Industrial production (index)	AMECO
ELM	B	Greece: Total imports (index)	AMECO
ESIP	B	Spain: Industrial production (index)	AMECO
ESM	B	Spain: Total imports (index)	AMECO

ESP	B	Spain: Wholesale prices (index)	AMECO
ETAMPH	GZ	Spillover elasticity: Sector M / Type PH	Set to zero
ETAMPI	GZ	Spillover elasticity: Sector M / Type PI	Set to zero
ETAMPR	GZ	Spillover elasticity: Sector M / Type PR	Set to zero
ETAMQH	GZ	Spillover elasticity: Sector M / Type QH	Set to zero
ETAMQI	GZ	Spillover elasticity: Sector M / Type QI	Set to zero
ETAMQR	GZ	Spillover elasticity: Sector M / Type QR	Set to zero
ETATPH	GZ	Spillover elasticity: Sector T / Type PH	Set to zero
ETATPI	GZ	Spillover elasticity: Sector T / Type PI	Set to zero
ETATPR	GZ	Spillover elasticity: Sector T / Type PR	Set to zero
ETATQH	GZ	Spillover elasticity: Sector T / Type QH	Set to zero
ETATQI	GZ	Spillover elasticity: Sector T / Type QI	Set to zero
ETATQR	GZ	Spillover elasticity: Sector T / Type QR	Set to zero
FIIP	B	Finland: Industrial production (index)	AMECO
FIM	B	Finland: Total imports (index)	AMECO
FRIP	B	France: Industrial production (index)	AMECO
FRM	B	France: Total imports (index)	AMECO
FRP	B	France: Wholesale prices (index)	AMECO
GECSFEC_E	GZ	Total annual EC funding for NSRF (in current euro)	Set to zero
GKO	B	Residual category of public capital expenditure	
GNDEX	G	Exogenous variant of GND, for use in policy feedback rule	Set to GND
GREVK	B	Non-NSRF capital revenue	
GTRABR	B	Government transfers abroad	
GTRK	B	Government capital transfers	
GTTI	B	Government trading and investment income	
HKIP	B	Hong Kong: Industrial production (index)	AMECO
HKM	B	Hong Kong: Total imports (index)	AMECO
HRIP	B	Croatia: Industrial production (index)	AMECO
HRM	B	Croatia: Total imports (index)	AMECO
HUIP	B	Hungary: Industrial production (index)	AMECO
HUM	B	Hungary: Total imports (index)	AMECO
IEIP	B	Ireland: Industrial production (index)	AMECO
IEM	B	Ireland: Total imports (index)	AMECO
IGV	B	Government investment: current prices	
IHGV	B	Public housing investment: current prices	
INIP	B	India: Industrial production (index)	AMECO
INM	B	India: Total imports (index)	AMECO
ISIP	B	Iceland: Industrial production (index)	AMECO
ISM	B	Iceland: Total imports (index)	AMECO
ITIP	B	Italy: Industrial production (index)	AMECO
ITM	B	Italy: Total imports (index)	AMECO
ITP	B	Italy: Wholesale prices (index)	AMECO
JPIP	B	Japan: Industrial production (index)	AMECO
JPM	B	Japan: Total imports (index)	AMECO
KIHP	G	Private housing investment (share of GDPE)	
KRIP	B	Korea: Industrial production (index)	AMECO
KRM	B	Korea: Total imports (index)	AMECO
KYCTREP	G	Repatriated manufacturing profits (YCTREP as a fraction of YCT)	
LG	B	Total employment in G-sector (thousands)	
LTIP	B	Lithuania: Industrial production (index)	AMECO
LTM	B	Lithuania: Total imports (index)	AMECO
LUIP	B	Luxembourg: Industrial production (index)	AMECO
LUM	B	Luxembourg: Total imports (index)	AMECO
LVIP	B	Latvia: Industrial production (index)	AMECO
LVM	B	Latvia: Total imports (index)	AMECO
MKIP	B	Macedonia: Industrial production (index)	AMECO

MKM	B	Macedonia: Total imports (index)	AMECO
MTIP	B	Malta: Industrial production (index)	AMECO
MTM	G	Malta: Total imports (index)	AMECO
MW1	G	Import fraction from DE (used in definition of PM)	Use export weights
MW2	G	Import fraction from IT (used in definition of PM)	Use export weights
MW3	G	Import fraction from FR (used in definition of PM)	Use export weights
MW4	G	Import fraction from ES (used in definition of PM)	Use export weights
MW5	G	Import fraction from NL (used in definition of PM)	Use export weights
MW6	G	Import fraction from BE (used in definition of PM)	Use export weights
MW7	G	Import fraction from UK (used in definition of PM)	Use export weights
MW8	G	Import fraction from SE (used in definition of PM)	Use export weights
MW9	G	Import fraction from US (used in definition of PM)	Use export weights
MXIP	B	Mexico: Industrial production (index)	AMECO
MXM	B	Mexico: Total imports (index)	AMECO
NELDDUM	GI	Dummy variable: exogenises NELD	Set to unity
NJUVDUM	GI	Dummy variable: exogenises NJUV	Set to unity
NLIP	B	Netherlands: Industrial production (index)	AMECO
NLM	B	Netherlands: Total imports (index)	AMECO
NLP	B	Netherlands: Wholesale prices (index)	AMECO
NOIP	B	Norway: Industrial production (index)	AMECO
NOM	B	Norway: Total imports (index)	AMECO
NWORKDUM	GI	Dummy variable: exogenises NWORK	Set to unity
NZIP	B	New Zealand: Industrial production (index)	AMECO
NZM	B	New Zealand: Total imports (index)	AMECO
OGNW	G	Non-wage element of OG	OGNWV=POG*OGNW
OVERHD	GZ	Overhead in ESF training schemes (fraction of wage bill)	Set to zero
PLIP	B	Poland: Industrial production (index)	AMECO
PLM	B	Poland: Total imports (index)	AMECO
POA	G	GDP deflator for agriculture (index)	
PTIP	B	Portugal: Industrial production (index)	AMECO
PTM	B	Portugal: Total imports (index)	AMECO
R_GSUB	G	GFS -> NA conversion of GSUB	GSUB_GFS=(R_GSUB)*GSUB
R_GTE	G	GFS -> NA conversion of GTE	GTE_GFS=(R_GTE)*GTE
R_GV	G	GFS -> NA conversion of GV	GV_GFS=(R_GV)*GV
R_IGV	G	GFS -> NA conversion of IGV	IGV_GFS=(R_IGV)*IGV
RDPCOFIN	GZ	Domestic public co-finance ratio [100*GECSFDP/(GECSFEC+GECSFDP)]	Set to zero
RGENW	G	Non-wage public consumption (constant prices)	GENW=PG*RGENW
RGEXPCO	G	Expenditure rate (used to derive GEXPCO from GV_GFS)	GEXPCO=RGEXPCO*GV_GFS
RGND	G	Implicit interest rate on national debt (percent)	GTRND = (RGND/100) * GND
RGREVCO	G	Implicit tax rate (used to derive GREVCO from GDPFCV)	GREVCO=RGREVCO*GDPFCV
RGSRUB	G	Implicit expenditure rate (used to derive GSRUB from GDPPC)	GSRUB=RGSRUB*GDPFC
RGSUB	G	Implicit expenditure rate (used to derive GSUB from GDPPCV)	GSUB=RGSUB*GDPFCV
RGTRE	G	Implicit tax rate (used to derive GTRE from CONS)	GTRE=RGTRE*CONS
RGTRSFD	GZ	Share of NSRF (D) funding going to human resources (ESF)	Set to zero
RGTRSFE	GZ	Share of NSRF (E) funding going to human resources (ESF)	Set to zero
RGTRSFP	GZ	Share of NSRF (P) funding going to human resources (ESF)	Set to zero
RGTRSOC	G	Implicit rate of social welfare payments (links GTRSOC to N)	GTRSOC = RGTRSOC*(PCONS*N)
RGTW	G	Implicit rate of wealth tax (on proxy base GDPEV)	GTW=RGTW*GDPEV
RGTYC	G	Implicit rat eof corporation tax (on base YC(-1))	GTYC=RGTYC*YC(-1)
RGTYPEX	G	Exogenous variant of RGTYPEX (for use in policy feedback rule)	Set equal to RGTYP

RGTYSOCE	G	Implicit rate of social insurance contribution by employers (on base YW)	GTYSOCE=RGTYSOCE*YW
RGTYSOCW	G	Implicit rate of social insurance contribution by employees (on base YW)	GTYSOCW=RGTYSOCW*YW
RIGVCSFD	GZ	Share of NSRF (D) funding going to physical infrastructure (ERDF)	Set to zero
RIGVCSFE	GZ	Share of NSRF (E) funding going to physical infrastructure (ERDF)	Set to zero
RIGVCSFP	GZ	Share of NSRF (P) funding going to physical infrastructure (ERDF)	Set to zero
RNL	B	Long-term interest rate (percent)	
ROIP	B	Romania: Industrial production (index)	AMECO
ROM	B	Romania: Total imports (index)	AMECO
RPRCOFIN	GZ	Domestic private co-finance ratio [100*GECSFPR/(GECSFEC+GECSFDP)]	Set to zero
RRANDD	GZ	R&D expenditures in the NSRF (constant prices)	Set to zero
RRDTCSF	GZ	Percentage share of TRI devoted to R&D investments	Set to zero
RTRIMD	GZ	Share of NSRF (D) aid to firms going to market services	Set to zero
RTRIME	GZ	Share of NSRF (E) aid to firms going to market services	Set to zero
RTRIMP	GZ	Share of NSRF (P) aid to firms going to market services	Set to zero
RTRITD	GZ	Share of NSRF (D) aid to firms going to manufacturing	Set to zero
RTRITE	GZ	Share of NSRF (E) aid to firms going to manufacturing	Set to zero
RTRITP	GZ	Share of NSRF (P) aid to firms going to manufacturing	Set to zero
RUIP	B	Russia: Industrial production (index)	AMECO
RUM	B	Russia: Total imports (index)	AMECO
SEARAT	G	Agriculture: ratio of self-employed to total	LASEMP = SEARAT*LA
SEBRAT	G	Building & construction: ratio of self-employed to total	LBSEMP = SEBRAT*LB
SEIP	B	Sweden: Industrial production (index)	AMECO
SEM	B	Sweden: Total imports (index)	AMECO
SEMRAT	G	Market services: ratio of self-employed to total	LMSEMP=SEMRAT*LM
SEP	B	Sweden: Wholesale prices (index)	AMECO
SETRAT	G	Manufacturing: ratio of self-employed to total	LTSEMP=SETRAT*LT
SIIP	B	Slovenia: Industrial production (index)	AMECO
SIM	B	Slovenia: Total imports (index)	AMECO
SKIP	B	Slovakia: Industrial production (index)	AMECO
SKM	B	Slovakia: Total imports (index)	AMECO
STATDIS	G	Statistical discrepancy (GDPM-GDPE)	NTS = GDPM-(CONS+I+G+DS) + STATDIS
STATDISV	G	Statistical discrepancy (GDPMV-GDPEV)	NTSV = GDPMV- (CONSV+IV+GV+DSV) + STATDISV
TB	GI	Hicks-neutral technical progress trend: B sector	Set equal to T
TFRACT	GZ	Parameter to adjust labour market status of ESF trainees	Set to zero
TKA	GI	Time trend: KA/OA	Set equal to T
TLA	GI	Time trend: LA	Set equal to T
TLFPR	GI	Time trend: LFPR	Set equal to T
TM	GI	Hicks-neutral technical progress trend: M sector	Set equal to T
TMUP	GI	Fraction of manufacturing wage paid to ESF trainees	Set to 0.3
TOA	GI	Time trend: OA	Set equal to T
TOB	GI	Time trend: OB	Set equal to T
TOM	GI	Time trend: OM	Set equal to T
TOT	GI	Time trend: OT	Set equal to T
TRATIO	GI	ESF trainee-instructor ratio	Set equal to 15
TRIP	B	Turkey: Industrial production (index)	AMECO
TRM	B	Turkey: Total imports (index)	AMECO
TT	GI	Hicks-neutral technical progress trend: T sector	Set equal to T
TYAFS	GI	Time trend: YAFS	Set equal to T
UKIP	B	United Kingdom: Industrial production (index)	AMECO
UKM	B	United Kingdom: Total imports (index)	AMECO

UKP	B	United Kingdom: Wholesale prices (index)	AMECO
UR_ALT	B	Unemployment rate in alternative labour market (drives migration)	AMECO
USIP	B	United States: Industrial production (index)	AMECO
USM	B	United States: Total imports (index)	AMECO
USP	B	United States: Wholesale prices (index)	AMECO
WIGM	B	Fraction of IGV consisting of machinery & equipment	
WIOM	B	Fraction of IOTH consisting of machinery & equipment	
XM1	G	Export fraction to DE (used in definition of PWORLD)	Subset of export weights
XW2	G	Export fraction to IT (used in definition of PWORLD)	Subset of export weights
XW3	G	Export fraction to FR (used in definition of PWORLD)	Subset of export weights
XW4	G	Export fraction to ES (used in definition of PWORLD)	Subset of export weights
XW5	G	Export fraction to NL (used in definition of PWORLD)	Subset of export weights
XW6	G	Export fraction to BE (used in definition of PWORLD)	Subset of export weights
XW7	G	Export fraction to UK (used in definition of PWORLD)	Subset of export weights
XW8	G	Export fraction to SE (used in definition of PWORLD)	Subset of export weights
XW9	G	Export fraction to US (used in definition of PWORLD)	Subset of export weights
XWAT	B	Export fraction to Austria (used in definition of OWIP and OWM)	
XWAU	B	Export fraction to Australia (used in definition of OWIP and OWM)	
XWBE	B	Export fraction to Belgium (used in definition of OWIP and OWM)	
XWBG	B	Export fraction to Bulgaria (used in definition of OWIP and OWM)	
XWBR	B	Export fraction to Brazil (used in definition of OWIP and OWM)	
XWCA	B	Export fraction to Canada (used in definition of OWIP and OWM)	
XWCH	B	Export fraction to Switzerland (used in definition of OWIP and OWM)	
XWCN	B	Export fraction to China (used in definition of OWIP and OWM)	
XWCY	B	Export fraction to Cyprus (used in definition of OWIP and OWM)	
XWCZ	B	Export fraction to Czech Republic (used in definition of OWIP and OWM)	
XWDE	B	Export fraction to Germany (used in definition of OWIP and OWM)	
XWDK	B	Export fraction to Denmark (used in definition of OWIP and OWM)	
XWEE	B	Export fraction to Estonia (used in definition of OWIP and OWM)	
XWEL	B	Export fraction to Greece (used in definition of OWIP and OWM)	
XWES	B	Export fraction to Spain (used in definition of OWIP and OWM)	
XWFI	B	Export fraction to Finland (used in definition of OWIP and OWM)	
XWFR	B	Export fraction to France (used in definition of OWIP and OWM)	
XWHK	B	Export fraction to Hong Kong (used in definition of OWIP and OWM)	
XWHR	B	Export fraction to Croatia (used in definition of OWIP and OWM)	
XWHU	B	Export fraction to Hungary (used in definition of OWIP and OWM)	
XWIE	B	Export fraction to Ireland (used in definition of OWIP and OWM)	

XWIN	B	Export fraction to India (used in definition of OWIP and OWM)	
XWIS	B	Export fraction to Island (used in definition of OWIP and OWM)	
XWIT	B	Export fraction to Italy (used in definition of OWIP and OWM)	
XWJP	B	Export fraction to Japan (used in definition of OWIP and OWM)	
XWKR	B	Export fraction to Korea (used in definition of OWIP and OWM)	
XWLT	B	Export fraction to Lithuania (used in definition of OWIP and OWM)	
XWLU	B	Export fraction to Luxembugh (used in definition of OWIP and OWM)	
XWLV	B	Export fraction to Latvia (used in definition of OWIP and OWM)	
XWMK	B	Export fraction to Macedonia (used in definition of OWIP and OWM)	
XWMT	B	Export fraction to Malta (used in definition of OWIP and OWM)	
XWMX	B	Export fraction to Mexico (used in definition of OWIP and OWM)	
XWNL	B	Export fraction to the Netherlands (used in definition of OWIP and OWM)	
XWNO	B	Export fraction to Norway (used in definition of OWIP and OWM)	
XWNZ	B	Export fraction to New Zealand (used in definition of OWIP and OWM)	
XWPL	B	Export fraction to Poland (used in definition of OWIP and OWM)	
XWPT	B	Export fraction to Portugal (used in definition of OWIP and OWM)	
XWRO	B	Export fraction to Romania (used in definition of OWIP and OWM)	
XWRU	B	Export fraction to Russia (used in definition of OWIP and OWM)	
XWSE	B	Export fraction to Sweden (used in definition of OWIP and OWM)	
XWSI	B	Export fraction to Slovenia (used in definition of OWIP and OWM)	
XWSK	B	Export fraction to Slovakia (used in definition of OWIP and OWM)	
XWTR	B	Export fraction to Turkey (used in definition of OWIP and OWM)	
XWUK	B	Export fraction to United Kingdom (used in definition of OWIP and OWM)	
XWUS	B	Export fraction to United States (used in definition of OWIP and OWM)	
YASA	B	Adjustment for stock appreciation (current prices)	
YCURAT	G	Fraction of total profits retained in firm (YCU/YC)	YCU=YCURAT*YC
YFN	B	BOP item: net factor income from abroad	
ZZEUR	B	Exchange rate: units of national currency to euro (ZZ=BG, CZ etc.)	AMECO
ZZGBP	B	Exchange rate: units of national currency to sterling (ZZ=BG, CZ etc.)	AMECO
ZZSEK	B	Exchange rate: units of national currency to Swedish crown (ZZ=BG, CZ etc.)	AMECO
ZZUSD	B	Exchange rate: units of national currency to US dollar (ZZ=BG, CZ etc.)	AMECO

Endogenous variables in Standard HERMIN country model

Basic input - AMECO	
Basic input - other source	
Generate & initialise	
Generate	

Name	Type **B**asic **Ge**nerated	Description	Comment
AMX	GZ	Adjusted M-sector CES efficiency parameter (incorporating spillovers)	Zero before calibration
ATX	GZ	Adjusted T-sector CES efficiency parameter (incorporating spillovers)	Zero before calibration
BP	G	Balance of payments (curent account)	
BPR	G	BP, expressed as percentage of GDPEV	
CONS	B	Household consumption (constant prices)	
CONSV	B	Household consumption (cuurent prices)	
CSFTRAN	GZ	Total EC funding injection (equals GECSFEC)	Set to zero
CSFTRANR	GZ	CSFTRAN expressed as a percentage of GDPEV	Set to zero
DEPV		Total (economy-wide) depreciation	
DS	B	Inventory stock changes	
DSV	B	Inventory stock changes	
ERFPB	G	Moving average of RFPB (expected relative factor price ratio)	
ERFPM	G	Moving average of RFPM (expected relative factor price ratio)	
ERFPT	G	Moving average of RFPT (expected relative factor price ratio)	
FDOM	G	Weighted measure of domestic demand (used in OM)	
FDOT	G	Weighted measure of domestic demand (used in OT)	
G	B	Government consumption	
GBOR	G	General government borrowing requirement (total)	GBOR = GEXP_GFS - GREV
GBORC	G	General government borrowing requirement (current)	GBORC = GEC_GFS - GREVC
GBORR	G	General government borrowing requirement (total), as percentage of GDPEV	GBORR = 100*GBOR/GDPEV
GDPE	G	GDP (expenditure basis)	GDPE=(CONS+I+G+DS)+NTS
GDPEV	G	GDP (expenditure basis)	GDPEV=(CONSV+IV+GV+DSV)+NTSV
GDPEV0	G	Exogenous version of GDPE (for use as no-NSRF baseline)	Set to GDPEV
GDPFC	G	GDP at factor cost (output basis)	GDPFC=(OT+OB+OM+OA+OG)-YRAFS
GDPFCV	G	GDP at factor cost (output basis)	GDPFCV= (OTV+OBV+OMV+OAV+OGV)-YAFS
GDPM	G	GDP at market prices (output basis)	GDPM=GDPFC+(GTRE-GSRUB)
GDPMV	G	GDP at market prices (output basis)	GDPMV=GDPFCV+(GTE-GSUB)
GEC	G	Total government current expenditure	GEC=GV+GSUB+GTR+GEXPCO
GEC_GFS	G	GFS version of GEC	GEC_GFS=GV_GFS+GSUB_GFS+GTR+GEXPCO
GECSF	GZ	Total NSRF funding (EC, DP and PR)	Set to zero
GECSFDP	GZ	NSRF funding: domestic public contribution	Set to zero
GECSFE	GZ	NSRF expenditures: EC financed element	Set to zero
GECSFEC	GZ	NSRF funding: EC contribution	Set to zero
GECSFP	GZ	NSRF expenditures: EC plus DP financed element	Set to zero
GECSFPR	GZ	NSRF funding: domestic private contribution	Set to zero
GECSFRA0	GZ	Ratio of total structural fund expenditure relative to GDPEV0 (percent)	Set to zero
GECSFRAE	GZ	Ratio of EC structural fund expenditure relative to GDPEV (percent)	Set to zero

GECSFRAP	GZ	Ratio of total public structural fund expenditure relative to GDPEV (percent)	Set to zero
GECSFRAT	GZ	Ratio of total structural fund expenditure relative to GDPEV (percent)	Set to zero
GECSFT	GZ	Total NSRF expenditure: current prices	Set to zero
GECSFTR	GZ	Total NSRF expenditure: constant prices	Set to zero
GEK	G	Total public capital expenditure (including NSRF)	GEK = IGV+GTRK+GKO
GEK_GFS	G	GFS version of GEK	GEK = IGV_GFS+GTRK+GKO
GENW	G	Non-wage government expenditure	GENW=PG*RGENW
GEXP	G	Total government current expenditure	GEXP = GEC + GEK
GEXP_GFS	G	GFS version of GEXP	GEXP_GFS = GEC_GFS + GEK_GFS
GEXPCO	B	Residual category of current expenditure	
GND	B	Public sector national debt	
GNP	G	Gross national product	GNP=GDPM+YRFN
GNPDOT	G	Growth rate of GNP	GNPDOT = 100*(GNP/GNP(-1) - 1.0)
GNPPC	G	GNP per head: constant prices	GNPPC = GNP/N
GNPV	G	Gross national product	GNPV=GDPMV+YFN
GREV	G	Total government revenue	GREV=GREVC+GREVK
GREVC	G	Total current revenue	GREVC=(GTE_GFS)+(GTY+GTW) +GTYSOC+GTTI+GREVCO
GREVCO	B	Other (non-tax) current revenue	
GSRUB	G	Subsidies: constant prices	
GSUB	B	Subsidies: current prices	
GSUB_GFS	B	GFS version of GSUB	
GTE	B	Revenue from indirect taxes: current prices	
GTE_GFS	B	GFS version of GTE	
GTR	G	Total government transfers	GTR=GTRSOC+GTRND+GTRABR
GTRE	G	Revenue from indirect taxes: constant prices	GTRE=RGTRE*CONS
GTRND	B	Interest payments on the national debt	
GTRSF	GZ	Total NSRF ESF expenditures	Set to zero
GTRSFDP	GZ	NSRF ESF expenditures: DP element	Set to zero
GTRSFEC	GZ	NSRF ESF expenditures: EC element	Set to zero
GTRSFPR	GZ	NSRF ESF expenditures: PR element	Set to zero
GTRSOC	G	Social transfer payments (income support, etc.)	
GTW	B	Revenue from wealth taxes	
GTY	G	Total revenue from taxes on income	GTY=GTYP+GTYC
GTYC	B	Revenue from corporation taxes	
GTYP	B	Revenue from taxes on personal incomes	
GTYSOC	G	Revenue from total social insurance contributions	GTYSOC=GTYSOCW+GTYSOCE
GTYSOCE	B	Revenue from total social insurance contributions by employers	
GTYSOCW	B	Revenue from total social insurance contributions by employees	
GV	B	Government consumption	
GV_GFS	B	GFS version of government consumption	
I	G	Total fixed capital formation	
IA	B	Fixed capital formation: agriculture	
IAV	B	Fixed capital formation: agriculture	
IB	B	Fixed capital formation: building & construction	
IBCTOT	G	Fixed capital formation by type of good: building & construction	IBCTOT = IGINFB + IOTHB
IBV	B	Fixed capital formation: building & construction	
IG	B	Fixed capital formation: government (non-NSRF)	
IGINF	G	Total fixed public capital formation: physical infrastructure: constant prices	IGINF = IGINFV/PIG
IGINFB	G	Building & construction element of IGINF	IGINFB = IGINF - IGINFM
IGINFM	G	Machinery & equipment element of IGINF	IGINFM = WIGM * IGINF
IGINFV	G	Total fixed public capital formation: physical infrastructure: current prices	IGINFV=IGV
IGV_GFS	B	GFS version of IGV	
IGVCSF	GZ	NSRF-related investment expenditures on infrastructure	Set to zero
IGVCSFDP	GZ	NSRF-related investment expenditures on infrastructure: DP element	Set to zero
IGVCSFEC	GZ	NSRF-related investment expenditures on infrastructure: EC element	Set to zero

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IGVCSFPR	GZ	NSRF-related investment expenditures on infrastructure: PR element	Set to zero
IH	G	Total investment in housing	IH=IHG+IHP
IHG	G	Investment in public housing	IHG=IHGV/PIH
IHP	G	Investment in private housing	IHP = KIHP*GDPE
IHV	G	Total investment in housing	IHV = PIH * IH
IM	B	Fixed capital formation: market services	
IMETOT	G	Fixed capital formation by type of good: machinery & equipment	IMETOT = IGINFM + IOTHM
IMV	B	Fixed capital formation: market services	
INH	G	Total fixed capital formation, excluding housing	INH = I - IH
IOTH	G	Fixed capital formation: private non-housing	IOTH = INH - IGINF
IOTHB	G	Fixed capital formation: private non-housing (building & construction)	IOTHB = IOTH - IOTHM
IOTHM	G	Fixed capital formation: private non-housing (machinery & equipment)	IOTHM = WIOM * IOTH
IT	B	Fixed capital formation: manufacturing	
ITV	B	Fixed capital formation: manufacturing	
IV	G	Total fixed capital formation	
KA	G	Capital stock: agriculture	
KB	G	Capital stock:building & construction	
KGINF	G	Capital stock: infrastructure	
KGINF0	G	Capital stock: infrastructure (for use as no-NSRF baseline)	Set equal to KGINF
KGINFR	G	Ratio of KGINF to KGINF0	
KM	G	Capital stock: market services	
KM0	G	Capital stock: market services (for use of no-NSRF baseline)	Set equal to KM
KMR	G	Ratio of KM to KM0	
KRTRIRD	G	Accumulated "stock" of R&D	KRTRIRD = RTRIRD + (1-0.08)*KRTRIRD(-1)
KRTRIRD0	G	Accumulated "stock" of R&D (for use of no-NSRF baseline)	Set equal to KRTRIRD
KRTRIRDR	G	Ratio of KRTRIRD to KRTRIRD0	KRTRIRDR=(KRTRIRD/KRTRIRD0)
KSFTRAIN	GZ	Accumulated "stock" of ESF trainee-years	Set to zero
KT	G	Capital stock: manufacturing	
KT0	G	Capital stock: manufacturing: (for use of no-NSRF baseline)	Set equal to KT
KTR	G	Ratio of KT to KT0	
KTRAIN	G	Historical stock of trained workers in private sector	KTRAIN=(YPLS*FPLS*DPLS+YHS* FHS*DHS+YNUT*FNUT*DNUT+YUT *FUT*DUT)*LF
KTRAIN0	G	Baseline (no-NSRF) stock of trained workers in private sector	Set equal to KTRAIN
KTRNR	G	Ratio of KTRAIN to KTRAIN0	
L	G	Total numbers employed	
LA	B	Numbers employed in agriculture	
LAEMP	G	Number of employees in agriculture	
LASEMP	G	Numbers self-employed in agriculture	
LB	B	Numbers employed in building & construction	
LBEMP	G	Number of employees in building & construction	
LBSEMP	G	Numbers self-employed in building & construction	
LF	B	Total labour force (ILO/LFS definition)	
LFPR	G	Labour force participation ratio	
LINS	GZ	Number of ESF instructors/trainers	Set to zero
LM	B	Numbers employed in market services	
LMEMP	G	Number of employees in market services	
LMSEMP	G	Numbers self-employed in market services	
LNA	G	Non-agricultural employment	
LPRA	G	Labour productivity in agriculture	
LPRADOT	G	Rate of change of LPRA	
LPRB	G	Labour productivity in building & construction	
LPRBDOT	G	Rate of change of LPRB	
LPRM	G	Labour productivity in market services	
LPRMDOT	G	Rate of change of LPRM	
LPROD	G	Total (economy-wide) labour productivity	
LPRODDOT	G	Rate of change of LPROD	
LPRT	G	Labour productivity in manufacturing	

LPRTDOT	G	Rate of change of LPRT	
LSHRA	G	Wage share of added-value: agriculture	
LSHRB	G	Wage share of added-value: building & construction	
LSHRM	G	Wage share of added-value: market services	
LSHRT	G	Wage share of added-value: manufacturing	
LT	B	Numbers employed in manufacturing	
LTEMP	G	Number of employees in manufacturing	
LTSEMP	G	Numbers self-employed in manufacturing	
N	G	Total population	
NDEP	G	Dependant population (NJUV+NELD)	
NDPFCV	G	Net domestic product at factor cost	
NELD	B	Population above working age	
NJUV	B	Population below working age	
NM	B	Net migration abroad (positive if net out-migration)	
NMRAT	G	NM expressed as a percentage of LF(-1)	NMRAT = 100*(NM/LF(-1))
NNPFCV	G	Net national product at factor cost	NNPFCV=NDPFCV+YFN+YASA
NTS	G	Net trade balance (exports of goods and services less imports of goods and services)	NTS = GDPM-(CONS+I+G+DS) + STATDIS
NTSV	G	Net trade balance (exports of goods and services less imports of goods and services)	NTSV = GDPMV-(CONSV+IV+GV+DSV) + STATDISV
NTSVR	G	NTSV, expressed as a percentage of GDPEV	NTSVR=100*NTSV/GDPEV
NWORK	B	Working age population	NWORK=N-(NJUV+NELD)
OA	B	GDP at factor cost: agriculture	
OAV	B	GDP at factor cost: agriculture	
OB	B	GDP at factor cost: building & construction	
OBV	B	GDP at factor cost: building & construction	
OG	B	GDP at factor cost: government	
OGNWV		Non-wage GDP at factor cost: government	
OGV	B	GDP at factor cost: government	
OM	B	GDP at factor cost: market services	
OMV	B	GDP at factor cost: market services	
OT	B	GDP at factor cost: manufacturing	
OTV	B	GDP at factor cost: manufacturing	
OWIP	G	World industrial output: index	See definition in model listing
OWM	G	World imports: index	See definition in model listing
PBE	G	Wholesale prices: Belgium (index)	
PCOMPT	G	International competitiveness (POT/PWORLD)	
PCONS	G	Household consumption: deflator (index)	
PCONSDOT	G	Annual rate of change of PCONS	
PDE	G	Wholesale prices: Germany (index)	
PDS	G	Stock changes: deflator (index)	
PES	G	Wholesale prices: Spain (index)	
PFR	G	Wholesale prices: France (index)	
PG	G	Government consumption: deflator (index)	
PGDPE	G	GDP (expenditure basis): deflator (index)	
PGDPFC	G	GDP (output basis, factor cost): deflator (index)	
PGDPM	G	GDP (output basis, market prices): deflator (index)	
PGNP	G	GNP (market prices): deflator (index)	
PI	G	Gross fixed capital formation: deflator (index)	
PIA	G	Gross fixed capital formation-total: deflator (index)	
PIB	G	Gross fixed capital formation-building & construction: deflator (index)	
PIG	G	Gross fixed capital formation-government: deflator (index)	
PIH	G	Gross fixed capital formationhousing: deflator (index)	
PIM	G	Gross fixed capital formation-manufacturing: deflator (index)	
PIT	G	Gross fixed capital formationmanufacturing: deflator (index)	
PITA	G	Wholesale prices: Italy (index)	
PKB	G	Cost of capital-building & construction: index)	
PKM	G	Cost of capital-market servies: index)	

PKT	G	Cost of capital-manufacturing: index)	
PM	G	Imports: deflator (index)	
PNL		Wholesale prices: the Netherlands (index)	
POB	G	GDP in building & construction: factor cost (index)	
POBDOT	G	Annual rate of change of POB	
POG	G	GDP in government: factor cost (index)	
POM	G	GDP in market services: factor cost (index)	
POMDOT	G	Annual rate of change of POM	
POT	G	GDP in manufacturing: factor cost (index)	
POTDOT	G	Annual rate of change of POT	
PSE	G	Wholesale prices: Sweden (index)	
PUK	G	Wholesale prices: United Kingdom (index)	
PUS	G	Wholesale prices: United Kingdom (index)	
PWORLD	G	World wholesale prices, local currency (index)	
PYAFS	G	Adjustment for financial services: deflator (index)	
PYFN	G	Net factor income from abroad: deflator (index)	
RATWT	G	After-tax average annual earnings in manufacturing: constant prices (index)	
RDEBT	G	ratio of national debt to GDPEV (percentage)	
RE	G	Relative employment rate (local versus alternative labour market)	
RFPB	G	Relative factor price ratio: building & construction (WB/PKB)	
RFPM	G	Relative factor price ratio: market services (WM/PKM)	
RFPT	G	Relative factor price ratio: manufacturing (WT/PKT)	
RGTYP	G	Implicit rate of direct personal income tax	
RIRLT	G	Real long-term rate of interest: percent)	
RRSA	G	Real rate of return on investments (index)	
RTRIRD	GZ	Percentage of NSRF TRI devoted to R&D	Set to zero
RULCB	G	Unit labour costs: building & construction (index)	
RULCM	G	Unit labour costs: market services (index)	
RULCT	G	Unit labour costs: manufacturing (index)	
S	G	Personal savings: constant prices	
SAV	G	Personal savings: current prices	
SAVRAT	G	Personal savings ratio	
SFTRAIN	GZ	ESF trainees supported: thousands	Set to zero
SFWAG	GZ	Wage bill element of ESF scheme	Set to zero
ST	G	Stock of inventories: constant prices	
TINC	G	Net indirect tax rate (used in PCONS)	TINC = RGTE - RGSUB
TRI	GZ	Total NSRF expenditure on direct aid to firms	Set to zero
TRIA	GZ	Total NSRF expenditure on direct aid to agricultural production	Set to zero
TRIADP	GZ	NSRF expenditure on direct aid to agricultural production: DP	Set to zero
TRIAEC	GZ	NSRF expenditure on direct aid to agricultural production: EC	Set to zero
TRIAPR	GZ	NSRF expenditure on direct aid to agricultural production: PR	Set to zero
TRIARL	GZ	NSRF expenditure on direct aid to agricultural production: constant price	Set to zero
TRIDP	GZ	Total NSRF expenditure on direct aid to firms: DP	Set to zero
TRIEC	GZ	Total NSRF expenditure on direct aid to firms: EC	Set to zero
TRIM	GZ	NSRF expenditure on direct aid to firms in market services: DP	Set to zero
TRIMDP	GZ	NSRF expenditure on direct aid to firms in market services: DP	Set to zero
TRIMEC	GZ	NSRF expenditure on direct aid to firms in market services: EC	Set to zero
TRIMPR	GZ	NSRF expenditure on direct aid to firms in market services: PR	Set to zero
TRIMRL	GZ	NSRF expenditure on direct aid to firms in market services: constant price	Set to zero
TRIPR	GZ	Total NSRF expenditure on direct aid to firms: PR	Set to zero
TRIRD	GZ	Total NSRF expenditure on direct aid to firms: R&D	Set to zero
TRIT	GZ	NSRF expenditure on direct aid to firms in manufacturing: DP	Set to zero
TRITDP	GZ	NSRF expenditure on direct aid to firms in manufacturing: EC	Set to zero
TRITEC	GZ	NSRF expenditure on direct aid to firms in manufacturing: PR	Set to zero
TRITPR	GZ	NSRF expenditure on direct aid to firms in manufacturing: constant price	Set to zero
TRITRL	GZ	NSRF expenditure on direct aid to firms in manufacturing: constant price	Set to zero

U	G	Numbers unemployed		
ULCB	G	Unit labour costs: building & construction		
ULCM	G	Unit labour costs: market services		
ULCT	G	Unit labour costs: manufacturing		
UR	G	Unemployment rate (percentage)		
URBAR	G	Two-year moving average of UR		
URP	G	Unemployment rate, adjusted for ESF schemes (used in WT equation)	Set equal to UR	
WA	G	Average annual earnings, agriculture		
WADOT	G	Annual percentage change in WA		
WB	G	Average annual earnings, building & construction		
WBDOT	G	Annual percentage change in WB		
WEDGE	G	Tax wedge (used in WT equation)		
WG	G	Average annual earnings, government		
WGDOT	G	Annual percentage change in WG		
WM	G	Average annual earnings, market services		
WMDOT	G	Annual percentage change in WM		
WNA	G	Average annual earnings, non-agriculture sector		
WNADOT	G	Annual percentage change in WNA		
WNH	G	Wealth (measured as accumulated savings)		
WT	G	Average annual earnings, manufacturing		
WTDOT	G	Annual percentage change in WT		
WTRAIN	G	Average annual earnings of ESF trainees	WTRAIN=TMUP*WT	
YAFS	G	Adjustment for financial services		
YC	G	Corporate profits	YC=NDPFCV-YWA -YWNA+YASA+YAFS	
YCA	G	Profits in agriculture (value added less wage bill)	YCA=OAV-YWA	
YCB	G	Profits in building & construction (value added less wage bill)	YCB=OBV-YWB	
YCM	G	Profits in market services (value added less wage bill)	YCM=OMV-YWM	
YCT	G	Profits in manufacturing (value added less wage bill)	YCT=OTV-YWT	
YCTREP	B	Repatriated profits		
YCU	G	Undistributed profits (i.e., retained in firms)		
YP	G	Private sector income		
YPER	G	Personal income		
YPERD	G	Personal disposable income		
YRAFS	G	Adjustment for financial services: constant prices		
YRFN	G	BOP: net factor income from abroad		
YRPERD	G	Personal disposable income: constant prices		
YPERDPC	G	Personal disposable income per capita: constant prices		
YW	G	Total wage bill		
YWA	G	Wage bill in agriculture		
YWB	G	Wage bill in building & construction		
YWG	G	Wage bill in government		
YWM	G	Wage bill in market services		
YWNA	G	Wage bill in non-agriculture sector		
YWT	G	Wage bill in manufacturing		

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Appendix 3: TSP Data Generation Files

A3.1 External data extraction from AMECO

```
? --------------------------------------------------------------
? TSP batch file to read data from AMECO_INTDAT.XLS, which was
? generated from AMECO database.
? --------------------------------------------------------------

?              Last modified December 5, 2008

? --------------------------------------------------------------

OPTIONS LIMERR=10 LIMWARN=1 LIMWNUMC=1;

FREQ A;

SMPL 1980 2006;

READ(FORMAT=EXCEL,FILE='C:\SIM\HTR5\AMECO_INTDAT.XLS')
BEM     BGM     CZM     DKM     DEM     EEM     IEM     ELM     ESM     FRM     ITM     CYM     LVM
        LTM     LUM
HUM     MTM     NLM     ATM     PLM     PTM     ROM     SIM     SKM     FIM     SEM     UKM     HRM
        MKM     TRM
USM     JPM     CAM     CHM     NOM     ISM     MXM     KOM     AUM     NZM     CNM     HKM     RUM
        BRM     INM
BEP     DEP     ESP     FRP     ITP     NLP     SEP     UKP     USP     BEIP    BGIP    CZIP
DKIP    DEIP    EEIP    IEIP    ELIP    ESIP    FRIP    ITIP
CYIP    LVIP    LTIP    LUIP    HUIP    MTIP    NLIP    ATIP
PLIP    PTIP    ROIP    SIIP    SKIP    FIIP    SEIP    UKIP
HRIP    MKIP    TRIP    USIP    JPIP    CAIP    CHIP    NOIP
ISIP    MXIP    KOIP    AUIP    NZIP    CNIP    HKIP    RUIP
BRIP    INIP    BEEUR   BGEUR   CZEUR   DEEUR   EEEUR   IEEUR
ELEUR   ESEUR   FREUR   ITEUR   CYEUR   LVEUR   LTEUR   HUEUR
MTEUR   NLEUR   PLEUR   PTEUR   ROEUR   SIEUR   SKEUR   SEEUR
UKEUR   TREUR   USEUR   UR_ALT
;

? ----------------------------------------------------------

WRITE(FORMAT=DATABANK,FILE='C:\SIM\HTR5\AMECO_INTDAT.tlb')
BEM     BGM     CZM     DKM     DEM     EEM     IEM     ELM     ESM     FRM     ITM     CYM     LVM
        LTM     LUM
HUM     MTM     NLM     ATM     PLM     PTM     ROM     SIM     SKM     FIM     SEM     UKM     HRM
        MKM     TRM
USM     JPM     CAM     CHM     NOM     ISM     MXM     KOM     AUM     NZM     CNM     HKM     RUM
        BRM     INM
BEP     DEP     ESP     FRP     ITP     NLP     SEP     UKP     USP     BEIP    BGIP    CZIP
DKIP    DEIP    EEIP    IEIP    ELIP    ESIP    FRIP    ITIP
CYIP    LVIP    LTIP    LUIP    HUIP    MTIP    NLIP    ATIP
PLIP    PTIP    ROIP    SIIP    SKIP    FIIP    SEIP    UKIP
HRIP    MKIP    TRIP    USIP    JPIP    CAIP    CHIP    NOIP
ISIP    MXIP    KOIP    AUIP    NZIP    CNIP    HKIP    RUIP
BRIP    INIP    BEEUR   BGEUR   CZEUR   DEEUR   EEEUR   IEEUR
ELEUR   ESEUR   FREUR   ITEUR   CYEUR   LVEUR   LTEUR   HUEUR
MTEUR   NLEUR   PLEUR   PTEUR   ROEUR   SIEUR   SKEUR   SEEUR
UKEUR   TREUR   USEUR   UR_ALT
;

STOP;
END;
```

A3.2 Extraction of Turkish National Accounts Data

```
? --------------------------------------------------------
? TSP batch file to read data from TURDAT.XLS, which was
? copied from the HERMIN worksheet of the XLS master data
? file HTR5_BASICDATA.XLS.

? The entire set of "basic" data is written to TURDAT.TLB

?               Last modified December 5, 2008

? --------------------------------------------------------

OPTIONS LIMERR=10 LIMWARN=1 LIMWNUMC=1;

FREQ A;

SMPL 1987 2006;

READ(FORMAT=EXCEL,FILE='C:\SIM\HTR5\TURDAT.XLS')

OTV     OT      ONV     ON      OBCV    OBC     OAV     OA      OGV     OG      CONSV   CONS    GV      G
ITOTV   ITOT    DSV     DS      XV      X       MV      M       DEPRT   GSUBTOT GTPI    LA      LAEMP
LT LTEMP        LLN     LLNEMP  LBC     LBCEMP  LG      YWA     YWT     YWN     YWBC    YWG     N       LF
NJUV    NELD    UOFF    GTYP    GTYC    GTYW    GTYSOCE GTYSOCW GTEVAT  GTEX
GTEM    GTEO    GREVO   YWG_GFS GENW_GFS        GEK     GTRNDI  GTRSOCW GTRU    GTRA
GTRO    GND     ITVSHR  INVSHR  IBCVSHR IAVSHR  IGVSHR  WIGME   WIOME
RGB     RST     RLT     XWDE    XWUK    XWUS    XWIT    XWFR    XWES    XWNL
XWRU    XWIQ    XWIL    XWRO    XWEL    XWBE    XWUA    XWBG    XWAL
XWIR    XWSA    XWPL    XWDK    XWAT    XWSE    XWUR    XWOT    MWDE
MWRU    MWIT    MWFR    MWUS    MWCN    MWUK    MWCH    MWES    MWJP
MWKR    MWUR    MWBE    MWIR    MWNL    MWRO    MWLB    MWAL    MWSA
MWTW    MWSE    MWAT    MWIN    MWSF    MWPL    MWBG    MWOT
;

? ------------------------------------------------------------

SMPL 1987 2006;

WRITE(FORMAT=DATABANK,FILE='C:\SIM\HTR5\TURDAT.tlb')

OTV     OT      ONV     ON      OBCV    OBC     OAV     OA      OGV     OG      CONSV   CONS    GV      G
ITOTV   ITOT    DSV     DS      XV      X       MV      M       DEPRT   GSUBTOT GTPI    LA      LAEMP
LT      LTEMP   LLN     LLNEMP  LBC     LBCEMP  LG      YWA     YWT     YWN     YWBC    YWG     N       LF
NJUV    NELD    UOFF    GTYP    GTYC    GTYW    GTYSOCE GTYSOCW GTEVAT  GTEX
GTEM    GTEO    GREVO   YWG_GFS GENW_GFS        GEK     GTRNDI  GTRSOCW GTRU    GTRA
GTRO    GND     ITVSHR  INVSHR  IBCVSHR IAVSHR  IGVSHR  WIGME   WIOME
RGB     RST     RLT     XWDE    XWUK    XWUS    XWIT    XWFR    XWES    XWNL
XWRU    XWIQ    XWIL    XWRO    XWEL    XWBE    XWUA    XWBG    XWAL
XWIR    XWSA    XWPL    XWDK    XWAT    XWSE    XWUR    XWOT    MWDE
MWRU    MWIT    MWFR    MWUS    MWCN    MWUK    MWCH    MWES    MWJP
MWKR    MWUR    MWBE    MWIR    MWNL    MWRO    MWLB    MWAL    MWSA
MWTW    MWSE    MWAT    MWIN    MWSF    MWPL    MWBG    MWOT
;

STOP;
END;
```

A3.3 Generation of HTR5 Model Database: HTR5DB.TLB

```
? ----------------------------------------------------------------
?
?                         HERDATA.TSP
?            Generates database: HTR5DB.TLB for Turkey
?
?                  Last modified: December 5, 2008
?
? ----------------------------------------------------------------

? The following variables are stored in the TURDAT.TLB database
? of "basic" data, copied over over from the HERMIN subfolder of
? the XLS spreadsheet HTR5_BASICDATA.XLS:

? OTV    OT     ONV     ON      OBCV    OBC     OAV     OA      OGV     OG      CONSV  CONS    GV     G
? ITOTV  ITOT   DSV     DS      XV      X       MV      M       DEP     GSUBTOT GTPI   LA      LAEMP
? LT     LTEMP  LLN     LLNEMP  LBC     LBCEMP  LG      YWA     YWT     YWN     YWBC   YWG     N      LF
? NJUV   NELD   UOFF    GTYP    GTYC    GTYW    GTYSOCE GTYSOCW GTEVAT  GTEX
? GTEM   GTEO   GREVO   YWG_GFS GNW     GEK     GTRNDI  GTRSOCW GTRU    GTRA
? GTRO   GND    ITVSHR  INVSHR  IBCVSHR IAVSHR  IGVSHR  WIGME   WIOME
? RGB    RST    RLT     XWDE    XWUK    XWUS    XWIT    XWFR    XWES    XWNL
? XWRU   XWIQ   XWIL    XWRO    XWEL    XWBE    XWUA    XWBG    XWAL
? XWIR   XWSA   XWPL    XWDK    XWAT    XWSE    XWUR    XWOT    MWDE
? MWRU   MWIT   MWFR    MWUS    MWCN    MWUK    MWCH    MWES    MWJP
? MWKR   MWUR   MWBE    MWIR    MWNL    MWRO    MWLB    MWAL    MWSA
? MWTW   MWSE   MWAT    MWIN    MWSF    MWPL    MWBG    MWOT


? These data series are generated and updated in HTR5_BASICDATA.XLS,
? and then copied into TURDAT.XLS (in format Excel Version 4.0). From
? there they are converted into TSP format using the batch file
? TURDAT.TSP and stored in TURDAT.TLB
?
? The objective of this TSP batch file is to generate all the required
? HTR5 HERMIN data and to create the complete TSP database HTR5DB.TLB
? for use in constructing the HERMIN model.
?
? ----------------------------------------------------------------

OPTIONS LIMERR=10 LIMWARN=1 LIMWNUMC=1;

? -------------------------------------------
? Frequency, observation period and data file
? Access the "basic" data in TURDAT.TLB
? -------------------------------------------

FREQ A;
IN TURDAT, AMECO_INTDAT;

? Set an encompassing data sample period and create the output
? database HTR5DB.TLB

SMPL 1987 2006;
OUT HTR5DB;

? -----------------------------------------------------------
? Trend variables and intervention variables
? -----------------------------------------------------------

? Set time index (T), 1987 = 1

SMPL 1987 2006;
READ T;
1  2  3  4  5  6  7  8  9  10
11 12 13 14 15 16 17 18 19 20;

T=T ;

? -------------------------------------------------------
? --- Define within-sample behavioural time variables ---
? -------------------------------------------------------

? Manufacturing output (OT) and HN technical progress
```

```
TOT=T;
TT=T;

? Market services output (ON) and HN technical progress

TON=T;
TN=T;

? Building & construction output (OBC) and HN technical progress

TOBC=T;
TBC=T;

? Agricultural output (OA), employment (LA) and capital stock (KA)

TOA=T;
TLA=T;
TKA=T;

? Labour force participation rate (LFPR)

TLFPR=T;

? Imports (M) and exports (X)

TM=T;
TX=T;

UNITY=1;

? ----------------------------------------
? World variables
? ----------------------------------------

? Interest rates (nominal long-term interest rate)

? RGB = Government bond rate
? RST = Short-term interest rate
? RLT = Long-term interest rate

? EXTRACT: RGB, RST, RLT

RGB=RGB;
RST=RST;
RLT=RLT;

? Turkish export shares (XW**)

? United States

XWUS=XWUS;

? Belgium

XWBE=XWBE;

? Germany

XWDE=XWDE;

? Greece

XWEL=XWEL;

? Spain

XWES=XWES;

? France

XWFR=XWFR;

? Italy

XWIT=XWIT;
```

```
? The Netherlands

XWNL=XWNL;

? Austria

XWAT=XWAT;


? Denmark

XWDK=XWDK;

? Sweden

XWSE=XWSE;

? United Kingdom

XWUK=XWUK;

? Poland

XWPL=XWPL;

? Russia

XWRU=XWRU;


? ----------------------------------------------------
?    Input and process data for global trading partners
? ----------------------------------------------------

? EXTRACT: Index of industrial output - derive rate of change

normal  ATIP,2000,1;
ATIPDOT=100*(ATIP/ATIP(-1)-1);

normal  BEIP,2000,1;
BEIPDOT=100*(BEIP/BEIP(-1)-1);

normal  CZIP,2000,1;
CZIPDOT=100*(CZIP/CZIP(-1)-1);

normal  DEIP,2000,1;
DEIPDOT=100*(DEIP/DEIP(-1)-1);

normal  DKIP,2000,1;
DKIPDOT=100*(DKIP/DKIP(-1)-1);

normal  EEIP,2000,1;
EEIPDOT=100*(EEIP/EEIP(-1)-1);

normal  ELIP,2000,1;
ELIPDOT=100*(ELIP/ELIP(-1)-1);

normal  ESIP,2000,1;
ESIPDOT=100*(ESIP/ESIP(-1)-1);

normal  FIIP,2000,1;
FIIPDOT=100*(FIIP/FIIP(-1)-1);

normal  FRIP,2000,1;
FRIPDOT=100*(FRIP/FRIP(-1)-1);

normal  IEIP,2000,1;
IEIPDOT=100*(IEIP/IEIP(-1)-1);

normal  ITIP,2000,1;
ITIPDOT=100*(ITIP/ITIP(-1)-1);

normal  JPIP,2000,1;
JPIPDOT=100*(JPIP/JPIP(-1)-1);

normal  LTIP,2000,1;
LTIPDOT=100*(LTIP/LTIP(-1)-1);
```

```
normal  LVIP,2000,1;
LVIPDOT=100*(LVIP/LVIP(-1)-1);

normal  NLIP,2000,1;
NLIPDOT=100*(NLIP/NLIP(-1)-1);

normal  NOIP,2000,1;
NOIPDOT=100*(NOIP/NOIP(-1)-1);

normal  PLIP,2000,1;
PLIPDOT=100*(PLIP/PLIP(-1)-1);

normal  PTIP,2000,1;
PTIPDOT=100*(PTIP/PTIP(-1)-1);

normal  SEIP,2000,1;
SEIPDOT=100*(SEIP/SEIP(-1)-1);

normal  UKIP,2000,1;
UKIPDOT=100*(UKIP/UKIP(-1)-1);

normal  USIP,2000,1;
USIPDOT=100*(USIP/USIP(-1)-1);

? EXTRACT: Total country imports, normalise and derive rate of change

normal  ATM,2000,1;
ATMDOT=100*(ATM/ATM(-1)-1);

normal  BEM,2000,1;
BEMDOT=100*(BEM/BEM(-1)-1);

normal  BGM,2000,1;
BGMDOT=100*(BGM/BGM(-1)-1);

normal  CHM,2000,1;
CHMDOT=100*(CHM/CHM(-1)-1);

normal  CYM,2000,1;
CYMDOT=100*(CYM/CYM(-1)-1);

normal  CZM,2000,1;
CZMDOT=100*(CZM/CZM(-1)-1);

normal  DEM,2000,1;
DEMDOT=100*(DEM/DEM(-1)-1);

normal  DKM,2000,1;
DKMDOT=100*(DKM/DKM(-1)-1);

normal  EEM,2000,1;
EEMDOT=100*(EEM/EEM(-1)-1);

normal  ELM,2000,1;
ELMDOT=100*(ELM/ELM(-1)-1);

normal  ESM,2000,1;
ESMDOT=100*(ESM/ESM(-1)-1);

normal  FIM,2000,1;
FIMDOT=100*(FIM/FIM(-1)-1);

normal  FRM,2000,1;
FRMDOT=100*(FRM/FRM(-1)-1);

normal  HUM,2000,1;
HUMDOT=100*(HUM/HUM(-1)-1);

normal  IEM,2000,1;
IEMDOT=100*(IEM/IEM(-1)-1);

normal  ITM,2000,1;
ITMDOT=100*(ITM/ITM(-1)-1);

normal  JPM,2000,1;
JPMDOT=100*(JPM/JPM(-1)-1);
```

```
normal   LTM,2000,1;
LTMDOT=100*(LTM/LTM(-1)-1);

normal   LVM,2000,1;
LVMDOT=100*(LVM/LVM(-1)-1);

normal   MTM,2000,1;
MTMDOT=100*(MTM/MTM(-1)-1);

normal   NLM,2000,1;
NLMDOT=100*(NLM/NLM(-1)-1);

normal   NOM,2000,1;
NOMDOT=100*(NOM/NOM(-1)-1);

normal   PLM,2000,1;
PLMDOT=100*(PLM/PLM(-1)-1);

normal   PTM,2000,1;
PTMDOT=100*(PTM/PTM(-1)-1);

normal   ROM,2000,1;
ROMDOT=100*(ROM/ROM(-1)-1);

normal   RUM,2000,1;
RUMDOT=100*(RUM/RUM(-1)-1);

normal   SEM,2000,1;
SEMDOT=100*(SEM/SEM(-1)-1);

normal   SIM,2000,1;
SIMDOT=100*(SIM/SIM(-1)-1);

normal   SKM,2000,1;
SKMDOT=100*(SKM/SKM(-1)-1);

normal   TRM,2000,1;
TRMDOT=100*(TRM/TRM(-1)-1);

normal   UKM,2000,1;
UKMDOT=100*(UKM/UKM(-1)-1);

normal   USM,2000,1;
USMDOT=100*(USM/USM(-1)-1);


? EXTRACT: Industrial prices, and derive rate of change

BEP=BEP;
BEPDOT=100*(BEP/BEP(-1)-1);

DEP=DEP;
DEPDOT=100*(DEP/DEP(-1)-1);

ESP=ESP;
ESPDOT=100*(ESP/ESP(-1)-1);

FRP=FRP;
FRPDOT=100*(FRP/FRP(-1)-1);

ITP=ITP;
ITPDOT=100*(ITP/ITP(-1)-1);

NLP=NLP;
NLPDOT=100*(NLP/NLP(-1)-1);

SEP=SEP;
SEPDOT=100*(SEP/SEP(-1)-1);

UKP=UKP;
UKPDOT=100*(UKP/UKP(-1)-1);

USP=USP;
USPDOT=100*(USP/USP(-1)-1);

? EXTRACT: Unemployment rate (alternative labour market-UK)
```

```
UR_ALT=UR_ALT;

? EXTRACT: Exchange rates against the euro

BEEUR=BEEUR;
BEEURDOT=100*(BEEUR/BEEUR(-1)-1);

CZEUR=CZEUR;
CZEURDOT=100*(CZEUR/CZEUR(-1)-1);

DEEUR=DEEUR;
DEEURDOT=100*(DEEUR/DEEUR(-1)-1);

EEEUR=EEEUR;
EEEURDOT=100*(EEEUR/EEEUR(-1)-1);

ELEUR=ELEUR;
ELEURDOT=100*(ELEUR/ELEUR(-1)-1);

ESEUR=ESEUR;
ESEURDOT=100*(ESEUR/ESEUR(-1)-1);

FREUR=FREUR;
FREURDOT=100*(FREUR/FREUR(-1)-1);

IEEUR=IEEUR;
IEEURDOT=100*(IEEUR/IEEUR(-1)-1);

ITEUR=ITEUR;
ITEURDOT=100*(ITEUR/ITEUR(-1)-1);

CYEUR=CYEUR;
CYEURDOT=100*(CYEUR/CYEUR(-1)-1);

LVEUR=LVEUR;
LVEURDOT=100*(LVEUR/LVEUR(-1)-1);

LTEUR=LTEUR;
LTEURDOT=100*(LTEUR/LTEUR(-1)-1);

HUEUR=HUEUR;
HUEURDOT=100*(HUEUR/HUEUR(-1)-1);

MTEUR=MTEUR;
MTEURDOT=100*(MTEUR/MTEUR(-1)-1);

NLEUR=NLEUR;
NLEURDOT=100*(NLEUR/NLEUR(-1)-1);

PLEUR=PLEUR;
PLEURDOT=100*(PLEUR/PLEUR(-1)-1);

PTEUR=PTEUR;
PTEURDOT=100*(PTEUR/PTEUR(-1)-1);

SIEUR=SIEUR;
SIEURDOT=100*(SIEUR/SIEUR(-1)-1);

SKEUR=SKEUR;
SKEURDOT=100*(SKEUR/SKEUR(-1)-1);

SEEUR=SEEUR;
SEEURDOT=100*(SEEUR/SEEUR(-1)-1);

UKEUR=UKEUR;
UKEURDOT=100*(UKEUR/UKEUR(-1)-1);

BGEUR=BGEUR;
BGEURDOT=100*(BGEUR/BGEUR(-1)-1);

ROEUR=ROEUR;
ROEURDOT=100*(ROEUR/ROEUR(-1)-1);

USEUR=USEUR;
USEURDOT=100*(USEUR/USEUR(-1)-1);
```

```
TREUR=TREUR;
TREURDOT=100*(TREUR/TREUR(-1)-1);

? Select 9 largest trading partners for Turkey and renormalise

TOTXWSHR=(XWDE+XWUK+XWIT+XWUS+XWFR+XWES+XWNL+XWEL+XWBE);

XW01=XWDE/TOTXWSHR;
XW02=XWUK/TOTXWSHR;
XW03=XWIT/TOTXWSHR;
XW04=XWUS/TOTXWSHR;
XW05=XWFR/TOTXWSHR;
XW06=XWES/TOTXWSHR;
XW07=XWNL/TOTXWSHR;
XW08=XWEL/TOTXWSHR;
XW09=XWBE/TOTXWSHR;

IPCTP1=DEIP;
IPCTP2=UKIP;
IPCTP3=ITIP;
IPCTP4=USIP;
IPCTP5=FRIP;
IPCTP6=ESIP;
IPCTP7=NLIP;
IPCTP8=ELIP;
IPCTP9=BEIP;

MCTP1=DEM;
MCTP2=UKM;
MCTP3=ITM;
MCTP4=USM;
MCTP5=FRM;
MCTP6=ESM;
MCTP7=NLM;
MCTP8=ELM;
MCTP9=BEM;

print XW01, XW02, XW03, XW04, XW05, XW06, XW07, XW08, XW09;
print IPCTP1,IPCTP2,IPCTP3,IPCTP4,IPCTP5,IPCTP6,IPCTP7,IPCTP8,IPCTP9;
print MCTP1, MCTP2, MCTP3, MCTP4, MCTP5, MCTP6, MCTP7, MCTP8, MCTP9;

? Construct OWIP as export-weighted average of the industrial output

OWIP =  XW01*log(IPCTP1) + XW02*log(IPCTP2) + XW03*log(IPCTP3)
        + XW04*log(IPCTP4) + XW05*log(IPCTP5) + XW06*log(IPCTP6)
        + XW07*log(IPCTP7) + XW08*log(IPCTP8) + XW09*log(IPCTP9) ;

OWIP = exp(OWIP);
OWIPDOT=100*(OWIP/OWIP(-1)-1);
print OWIP, OWIPDOT;

? Construct OWM as export-weighted average of the imports

OWM =   XW01*log(MCTP1) + XW02*log(MCTP2) + XW03*log(MCTP3)
        + XW04*log(MCTP4) + XW05*log(MCTP5) + XW06*log(MCTP6)
        + XW07*log(MCTP7) + XW08*log(MCTP8) + XW09*log(MCTP9)  ;

OWM = exp(OWM);
OWMDOT=100*(OWM/OWM(-1)-1);
print OWM, OWMDOT;

? -----------------------------------------------------------------

? Convert foreign prices to local currency; index 2000=1

? The price index in EURO (PDE, PITA, etc.) is converted to the currency of
? the country being modelled by multiplying by a national currency per EURO
? index.  Note the switch in notation for Italy (PITA in place of PIT), since
? PIT is used elsewhere.

PDE= (DEP/DEEUR) * (TREUR/57.48200);
print PDE;
normal PDE,2000,1;
print PDE, DEP, DEEUR, TREUR;

PITA=(ITP/ITEUR) * (TREUR/57.48200);
print PITA;
```

```
normal PITA,2000,1;
print PITA, ITP, ITEUR, TREUR;

PFR= (FRP/FREUR) * (TREUR/57.48200);
print PFR;
normal PFR,2000,1;
print PFR, FRP, FREUR, TREUR;

PES= (ESP/ESEUR) * (TREUR/57.48200);
print PES;
normal PES,2000,1;
print PES, ESP, ESEUR, TREUR;

PNL= (NLP/NLEUR)  * (TREUR/57.48200);
print PNL;
normal PNL,2000,1;
print PNL, NLP, NLEUR, TREUR;

PBE= (BEP/BEEUR) * (TREUR/57.48200);
print PBE;
normal PBE,2000,1;
print PBE, BEP, BEEUR, TREUR;

? Non-euro-zone wholesale prices (UK, Sweden, USA)

? The price index in sterling, Swedisk Kroner and US dollars (UKP, SEP and USP)
? is converted to the currency of the country being modelled by multiplying by
? a national currency/foreign currency index.

PUK= (UKP/UKEUR) * (TREUR/94.31318);
print PUK;
normal PUK,2000,1;
print PUK, UKP, UKEUR, TREUR;

PSE= (SEP/SEEUR) * (TREUR/6.80647);
print PSE;
normal PSE,2000,1;
print PSE, SEP, SEEUR, TREUR;

PUS= (USP/USEUR) * (TREUR/62.23690);
print PUS;
normal PUS,2000,1;
print PUS, USP, USEUR, TREUR;

? "World" manufacturing price (PWORLD) and national import price (PM)

? The "world" manufacturing price for the country being modelled is an
? export-weighted set of wholesale price indices, in the local currency.
? The export weights (XWP1 - XWP6) are re-normalised versions of the
? full set of export weights (XWYY)

print XWDE, XWIT, XWFR, XWNL, XWUK, XWUS;
print PDE,  PITA, PFR,  PNL,  PUK,  PUS;

XWP1=XWDE/(XWDE+XWIT+XWFR+XWNL+XWUK+XWUS);
XWP2=XWIT/(XWDE+XWIT+XWFR+XWNL+XWUK+XWUS);
XWP3=XWFR/(XWDE+XWIT+XWFR+XWNL+XWUK+XWUS);
XWP4=XWNL/(XWDE+XWIT+XWFR+XWNL+XWUK+XWUS);
XWP5=XWUK/(XWDE+XWIT+XWFR+XWNL+XWUK+XWUS);
XWP6=XWUS/(XWDE+XWIT+XWFR+XWNL+XWUK+XWUS);
TEMPSUM=XWP1+XWP2+XWP3+XWP4+XWP5+XWP6;

print XWP1, XWP2, XWP3, XWP4, XWP5, XWP6 TEMPSUM;

PWORLD = XWP1*log(PDE)+XWP2*log(PITA)+XWP3*log(PFR)+XWP4*log(PNL) +
         XWP5*log(PUK)+XWP6*log(PUS);

PWORLD=exp(PWORLD);
PWORLDOT=100*(PWORLD/PWORLD(-1)-1);
print PWORLD, PWORLDOT;

? Use export weights (XWP*) for endogenising PM as well (MWP*)

MWP1=XWP1;
MWP2=XWP2;
MWP3=XWP3;
MWP4=XWP4;
```

```
MWP5=XWP5;
MWP6=XWP6;

? EXTRACT: Alternative unemployment rate, taken as the UK

UR_ALT=UR_ALT;

? ------------------------------------------------------------
?     End on input and processing of international data
? ------------------------------------------------------------




? ------------------------------------------------------------
? EXTRACT: Total Investment Data
?
? EXTRACT: Sectoral investment data do not always sum exactly
? to total investment. This is dealt with by using sectoral
? weights to derive sectoral investment from overall total.
? ------------------------------------------------------------

ITOTV=ITOTV;
ITOT=ITOT;
PITOT=ITOTV/ITOT;

? Input the sectoral investment shares for T, N, BC, A and G

ITVSHR =ITVSHR;
INVSHR =INVSHR;
IBCVSHR=IBCVSHR;
IAVSHR =IAVSHR;
IGVSHR =IGVSHR;

TOTSHR=ITVSHR+INVSHR+IBCVSHR+IAVSHR+IGVSHR;
print ITVSHR INVSHR IBCVSHR IAVSHR IGVSHR TOTSHR;


?---------------------------------------------------
?            Manufacturing sector (T)
?      Input data: OTV, OT, LT, LTEMP, YWT
?---------------------------------------------------

? EXTRACT: OTV, OT

OTV=OTV;
OT=OT;

POT=OTV/OT;
POTDOT=100*(POT/POT(-1)-1);
OTDOT=100*(OT/OT(-1)-1);

? Total fixed investment

ITV=ITVSHR*ITOTV;
IT=ITV/PITOT;
PIT=ITV/IT;
PITDOT=100*(PIT/PIT(-1)-1);
ITRAT=100*IT/OT;
print ITRAT, PITDOT;

? Generate capital stock in T-sector (Note: 1987 KT/IT ratio = 10)
? assuming a 5% rate of depreciation

print IT;
SMPL 1987 1987;
KT=IT*10;
SMPL 1988 2006;
GENR KT=IT+(1-0.05)*KT(-1);
SMPL 1987 2006;
print IT, KT;

? Number of gainfully occupied persons and employees

? EXTRACT LT, LTEMP

LT=LT;
LTEMP=LTEMP;
```

```
? 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 SETRAT;

? Labour productivity and growth rate

LPRT=OT/LT;
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: Note fixed 10% rate of return assumed (RRSA)

RRSA=10;
print RRSA;

? Cost of capital

PKT=PIT*(0.05+RRSA/100);
RFPT=WT/PKT;
RFPTDOT=100*(RFPT/RFPT(-1)-1);
ERFPT=(RFPT+0.75*RFPT(-1))/(1.0+0.75);
print WT, PKT, RFPT, RFPTDOT;

? Unit labour cost and growth rate of unit labour cost

ULCT=YWT/OT;
ULCTDOT=100*(ULCT/ULCT(-1)-1);
print ULCT, ULCTDOT;

? Real unit labour cost and growth rate of real unit labour cost

RULCT=ULCT/POT;
RULCTDOT=100*(RULCT/RULCT(-1)-1);
print RULCT, ULCTDOT, RULCTDOT;

? Competition measure (in Turkish currency terms)

PCOMPT=POT/PWORLD;
print PCOMPT;

? Wage share of added-value

LSHRT=100*YWT/OTV;
print LSHRT, YWT, OTV;

? Corporate profits (notional)

YCT=OTV-YWT;
YCTRAT=100*YCT/OTV;
print YCTRAT;




? ------------------------------------------
?    Market services sector (N) (excl B&C)
?    Input data: ONV, ON, LLN, LLNEMP, YWN
?
?  Note: LN is reserved notation for log
?  in Winsolve, so we switch from LN to LLN
```

```
? ----------------------------------------

? EXTRACT ONV, ON

ONV=ONV;
ON=ON;

PON=ONV/ON;
PONDOT=100*(PON/PON(-1)-1);
ONDOT=100*(ON/ON(-1)-1);

? Total investment in market services

INV=INVSHR*ITOTV;
IN=INV/PITOT;
PIN=INV/IN;
PINDOT=100*(PIN/PIN(-1)-1);
INRAT=100*IN/ON;
print INRAT;

? Generate capital stock in N-sector (Note: 1987 KN/IN ratio is 10)
? assuming a 3% rate of depreciation

print IN;
SMPL 1987 1987;
KN=IN*10;
SMPL 1988 2006;
GENR KN=IN+(1-0.03)*KN(-1);
SMPL 1987 2006;
print IN, KN;

? Number of gainfully occupied persons

? EXTRACT LLN and LLNEMP

LLN=LLN;
LLNEMP=LLNEMP;

? Calculate the number of self-employed

LLNSEMP=LLN-LLNEMP;

? Define the SE to total employment ratio for use in the model

SENRAT=LLNSEMP/LLN;
print SENRAT;

? Labour productivity and growth rate

LPRN=ON/LLN;
LPRNDOT=100*(LPRN/LPRN(-1)-1);
print LPRNDOT;

? Wage bill

? EXTRACT YWN

YWN=YWN;

? Calculate average annual earnings (WN)

WN=YWN/LLNEMP;
WNDOT=(WN/WN(-1)-1)*100;
print WN WNDOT;

? Cost of Capital

PKN=PIN*(0.03+RRSA/100);
RFPN=WN/PKN;
ERFPN=(RFPN+0.75*RFPN(-1))/(1.0+0.75);
RFPNDOT=100*(RFPN/RFPN(-1)-1);
print WN, PKN, RFPN, RFPNDOT;

? Unit labour cost (nominal) and growth rate

ULCN=YWN/ON;
ULCNDOT=100*(ULCN/ULCN(-1)-1);
```

```
? Real unit labour cost  and labour share

RULCN=ULCN/PON;
RULCNDOT=100*(RULCN/RULCN(-1)-1);
print ULCNDOT, RULCNDOT;

? Wage share of added value

LSHRN=100*YWN/ONV;
print LSHRN, YWN, ONV;

? Corporate profits, (notional)

YCN=ONV-YWN;
YCNRAT=100*YCN/ONV;
print YCNRAT;




? -----------------------------------------
?         Building and construction
?      Input data: OBCV, OBC, LBC, YWBC
? -----------------------------------------

? EXTRACT OBCV, OBC

OBCV=OBCV;
OBC=OBC;

POBC=OBCV/OBC;
POBCDOT=100*(POBC/POBC(-1)-1);
OBCDOT=100*(OBC/OBC(-1)-1);

? Total investment in building & construction

IBCV=IBCVSHR*ITOTV;
IBC=IBCV/PITOT;
PIBC=IBCV/IBC;
PIBCDOT=100*(PIBC/PIBC(-1)-1);
IBCRAT=100*IBC/OBC;
print IBCRAT;

? Generate capital stock in BC-sector (Note: 1987 KBC/IBC ratio is 10)
? assuming a 3% rate of depreciation

print IBC;
SMPL 1987 1987;
KBC=IBC*10;
SMPL 1988 2006;
GENR KBC=IBC+(1-0.03)*KBC(-1);
SMPL 1987 2006;
print IBC, KBC;

? Number of gainfully occupied persons

? EXTRACT LBC and LBCEMP

LBC=LBC;
LBCEMP=LBCEMP;

? 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 SEBCRAT;

? Labour productivity and growth rate

LPRBC=OBC/LBC;
LPRBCDOT=100*(LPRBC/LPRBC(-1)-1);
print LPRBCDOT;

? Wage bill
```

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```
? 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*(0.03+RRSA/100);
RFPBC=WBC/PKBC;
ERFPBC=(RFPBC+0.75*RFPBC(-1))/(1.0+0.75);
RFPBCDOT=100*(RFPBC/RFPBC(-1)-1);
print WBC, PKBC, RFPBC, RFPBCDOT;

? 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 ULCBCDOT, RULCBCDOT;

? Wage share of added value

LSHRBC=100*YWBC/OBCV;
print LSHRBC, YWBC, OBCV;

? Corporate profits, (notional)

YCBC=OBCV-YWBC;
YCBCRAT=100*YCBC/OBCV;
print YCBCRAT;


?----------------------------------------
?        Agriculture sector (A)
?  Input data: OAV, OA, LA, LAEMP,YWA
?----------------------------------------

? EXTRACT OAV, OA

OAV=OAV;
OA=OA;

POA=OAV/OA;
POADOT=100*(POA/POA(-1)-1);
print POADOT;

? Number of gainfully occupied persons

? EXTRACT LA and LAEMP

LA=LA;
LAEMP=LAEMP;

? Calculate number of self-employed

LASEMP=LA-LAEMP;

? Define the SE to total employment ratio for use in the model

SEARAT=LASEMP/LA;
print SEARAT;

LPRA=OA/LA;

? Total investment in agriculture

IAV=IAVSHR*ITOTV;
```

```
IA=IAV/PITOT;
PIA=IAV/IA;
IARAT=100*IA/OA;
print IARAT;

? Generate capital stock in A-sector (1987 KA/IA ratio = 10)
? assuming a 2.5% rate of depreciation

print IA;
SMPL 1987 1987;
KA=10*IA;
smpl 1988 2006;
GENR KA=IA+(1-0.025)*KA(-1);
SMPL 1987 2006;
print IA, KA;

? Wage bill

? EXTRACT YWA

YWA=YWA;

? Calculate average annual wage earnings in agriculture (WA)

WA=YWA/LAEMP;
WADOT=(WA/WA(-1)-1)*100;
print WA WADOT;

? Non-wage income in agriculture (YCA)

YCA=OAV-YWA;
YCARAT=100*YCA/OAV;
print YCARAT;

? Wage share of added value

LSHRA=100*YWA/OAV;
print LSHRA, YWA,OAV;


?----------------------------------------
?        Government sector (G)
?     Input data: OGV, OG, LG, YWG
?----------------------------------------

? EXTRACT: OGV OG

OGV=OGV;
OG=OG;

POG=OGV/OG;
POGDOT=100*(POG/POG(-1)-1);
print POGDOT;

? EXTRACT LG

LG=LG;
LPRG=OG/LG;


? Wage bill

? EXTRACT YWG

YWG=YWG;

WG=YWG/LG;
WGDOT=(WG/WG(-1)-1)*100;
print WG WGDOT;


? Investment by government sector

IGV=IGVSHR*ITOTV;
IG=IGV/PITOT;
PIG=IGV/IG;
PIGDOT=100*(PIG/PIG(-1)-1);
```

```
print PIGDOT;

? Real public investment (mainly infrastructure)

IG=IGV/PIG;

? Generate (notional) capital stock (mainly infrastructure) in G-sector
? Take 1987 KG/IG ratio = 20 and assume a 2% rate of depreciation

print IG;
SMPL 1987 1987;
KG=20*IG;
SMPL 1988 2006;
GENR KG=IG+(1-0.02)*KG(-1);
SMPL 1987 2006;

? Investment rate in G sector

IGRAT=100*IG/OG;
print IGRAT;

OGNWV=OGV-YWG;
OGNWVRAT=100*OGNWV/OGV;
print OGNWVRAT;
OGNW=OGNWV/POG;


? -------------------------------------------------
?      Demographic and labour supply data
?          Input data: N, NJUV, NELD, LF
? -------------------------------------------------

? Population is defined as follows:
? N:    total population
? NJUV: population less than working age
? NWORK: population of working age
? NELD: population over working age

? EXTRACT: NJUV, NELD, N

NJUV=NJUV;
NELD=NELD;
N=N;

? Define "working age" population

NWORK = N-(NJUV+NELD);
print NWORK N NJUV NELD;

? The "dependent" (non-working) population

NDEP = NJUV+NELD;

? Labour Force

? EXTRACT LF:

LF=LF;

? Generate numbers unemployed (ILO measure)

U=LF-(LT+LLN+LBC+LA+LG);
print U;

? Participation rate in percent. The definition of working age population is
? NWORK+NELD

LFPR=100*LF/(NWORK+NELD);
print LFPR LF NWORK;

? Gainfully occupied persons (total, private non-ag, private and non-ag)

L=LT+LLN+LBC+LA+LG;
LPNA=LT+LLN+LBC;
LP=LPNA+LA;
LNA=LT+LLN+LBC+LG;
```

```
? Total self-employed LSEMP

LSEMP=LASEMP+LTSEMP+LLNSEMP+LBCSEMP;

? Total employees LEMP

LEMP=L-LSEMP;
print LEMP, LSEMP, L;

? Numbers employed in non-agricultural sector
? Employees LNAEMP and self-employed LNASEMP

LNAEMP=LTEMP+LLNEMP+LBCEMP+LG;
LNASEMP=LNA-LNAEMP;

? Numbers employed in private non-agricultural sector
? Employees LPNAEMP and self-employed LPNASEMP

LPNAEMP=LTEMP+LLNEMP+LBCEMP;
LPNASEMP=LPNA-LPNAEMP;

? Define ILO unemployment rate

UR=100*(U/(LF));
URP=UR;

print UR;

? Moving average unemployment rate over two periods

URBAR=(UR+UR(-1))/2.0;


? -------------------------------------------------------------
?                        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 PCONSDOT;

? Government consumption GV

? EXTRACT: GV and G:

GV=GV;
G=G;

PG=GV/G;
PGDOT=100*(PG/PG(-1)-1);
print PGDOT;
GENW=GV-YWG;

? Private & public housing investment (set to zero initially)

IHPV=0;
PIH=1.0;
IHGV  = 0;
IHG=0;
IHV   = IHPV + IHGV;
IHP=IHPV/PIH;
IH = IHP + IHG;

? Total real investment

I=IT+IN+IBC+IA+IG+IH;
IP=IT+IN+IBC+IA;
INH=I-IH;
```

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```
? 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;

? Re-name IGV as IGINFV

IGINFV=IGV;
IGINF=IGINFV/PIG;

? Generate total stock of infrastructure (from IGINF)
? Initial 1987 KGINF/IGINF) ratio was set at 20 (see KG above)
? Assume a 2% rate of depreciation

print IGINF;
SMPL 1987 1987;
KGINF=20*(IGINF);
SMPL 1988 2006;
GENR KGINF=IGINF+(1-0.02)*KGINF(-1);
SMPL 1987 2006;

IGINFME=WIGME*IGINF;
IGINFBC=IGINF-IGINFME;
IOTH=INH-IGINF;
IOTHME=WIOME*IOTH;
IOTHBC=IOTH-IOTHME;

? Define the split of total investment into two types of good:
? building & construction (IBCTOT) and machinery & equipment (IMETOT)

IBCTOT=IGINFBC+IOTHBC;
IMETOT=IGINFME+IOTHME;

? IHV added

IV=ITV+INV+IBCV+IAV+IGV+IHV;
IPV=ITV+INV+IBCV+IAV;
PI=IV/I;
PIAGG=PI;
PIDOT=100*(PI/PI(-1)-1);

? Private sector capital stock

KP=KT+KN+KBC+KA;

? EXTRACT: DSV, DS:

DSV=DSV;
DS=DS;

PDS=DSV/DS;

? Generate stock level of inventories (ST)
? Assume initial stock/output ratio is 25%

SMPL 1987 1987;
ST=0.25*OT;
SMPL 1988 2006;
GENR ST=DS+ST(-1);
SMPL 1987 2006;

? Exports and imports

? EXTRACT: XV, X

XV=XV;
X=X;

PX=XV/X;
PXDOT=100*(PX/PX(-1)-1);
```

```
        print PXDOT;


        ? EXTRACT: MV, M

        MV=MV;
        M=M;

        print M, MV;

        PM=MV/M;
        PMDOT=100*(PM/PM(-1)-1);

        ? Convert PM to equivalent euro denomination.

        PMEUR=PM/(TREUR/0.0011172);
        print PMEUR, PM, TREUR;
        PMEURDOT=100*(PMEUR/PMEUR(-1)-1);
        print PMDOT, PMEURDOT;

        ? 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);

        ? (Restricted) final demand (FD)

        FD = CONS+G+I+X;

        GDPEV = GDAV + NTSV;
        GDPE  = GDA  + NTS;

        PGDPE    = GDPEV/GDPE;
        PGDPEDOT = 100*(PGDPE/PGDPE(-1)-1);
        GDPEDOT=100*(GDPE/GDPE(-1)-1);
        print PGDPE, PGDPEDOT, GDPEDOT;



        ? Construction of GDP on output basic.  Note that this is not valued
        ? at factor cost.  It includes net indirect taxes on production, but
        ? excludes import duties (see GDP-Prod worksheet).

        GDPFCV=OTV+ONV+OBCV+OAV+OGV;
        GDPFC=OT+ON+OBC+OA+OG;
        GDPFCPC=GDPFC/N;

        GDPFCDOT=100*(GDPFC/GDPFC(-1)-1);
        PGDPFC=GDPFCV/GDPFC;
        PGDPFCDT=100*(PGDPFC/PGDPFC(-1)-1);

        print GDPFCDOT,PGDPFCDT;

        ? ------------------------------------------------------------
        ? I/O weights for definition of weighted final demand measures
        ?
        ? Initially, these are estimates based on the Portuguese
        ? sources and use I/O data for 1997
        ? ------------------------------------------------------------

        PARAM AIOTC   1.0;
        PARAM AIOTG   1.0;
        PARAM AIOTB   1.0;
        PARAM AIOTM   1.0;

        PARAM AIONC   1.0;
        PARAM AIONG   1.0;
        PARAM AIONB   1.0;
        PARAM AIONM   1.0;
```

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```
RGENW=GENW/PG;

FDOT=AIOTC*CONS+AIOTG*RGENW+AIOTB*(IBCTOT+IH)+AIOTM*IMETOT;
FDON=AIONC*CONS+AIONG*RGENW+AIONB*(IBCTOT+IH)+AIONM*IMETOT;




? ---------------------------------------
? Tax and other government revenue data
? ---------------------------------------

SMPL 1989 2006;

YWNA=YWT+YWN+YWBC+YWG;
YW=YWNA+YWA;

? Personal income tax and implicit rate

GTYP=GTYP;
RGTYP=GTYP/YW;
RGTYPEX=RGTYP;

? Social insurance contributions: GTYSOCW and GTYSOCE

GTYSOCW=GTYSOCW;
GTYSOCE=GTYSOCE;

? Define total GTYSOC as GTYSOCW+GTYSOCE

GTYSOC=GTYSOCW+GTYSOCE;

? Define implicit rate of workers social insurance contributions

RGTYSOCW=GTYSOCW/YW;

? Define implicit rate of employers social insurance contributions

RGTYSOCE=GTYSOCE/YW;

print RGTYSOCW, RGTYSOCE;

? Corporation tax: implicit rate defined later after YC definition

GTYC=GTYC;

? Wealth tax and implicit rate

GTYW=GTYW;
RGTYW=GTYW/GDPFCV;

? Total taxes on income and wealth

GTY=GTYP+GTYSOC+GTYC+GTYW;

? VAT and implicit rate

GTEVAT=GTEVAT;
RGTEVAT=GTEVAT/CONSV;

? Excise duties

GTEX=GTEX;
RGTEX=GTEX/CONS;

? Import duties

GTEM=GTEM;
RGTEM=GTEM/MV;

? Other indirect taxes

GTEO=GTEO;
RGTEO=GTEO/GDPFCV;

? Total indirect taxes
```

```
GTE=GTEVAT+GTEX+GTEM+GTEO;
RGTE=GTE/GDPFCV;

? Total (direct and indirect) tax revenue

GREVTAX=GTE+GTY;

? Other (non-tax) revenue

GREVO=GREVO;
RGREVO=GREVO/GDPFCV;

? Total government revenue

GREV=GREVTAX+GREVO;




? ----------------------------------------
?      Public expenditure data categories
? ----------------------------------------

? Current expenditure of goods and services (GV_GFS)

YWG_GFS=YWG_GFS;
GENW_GFS=GENW_GFS;
GV_GFS=YWG_GFS+GENW_GFS;


? Construction of transfer payments

? National debt interest payments

GTRNDI=GTRNDI;

? Extract GND

GND=GND;

RGTRNDI=GTRNDI/GND;
print GTRNDI, GND, RGTRNDI;

? Unemployment income support transfers

GTRU=GTRU;
RGTRU=GTRU/U;
print RGTRU;

? Extract social welfare transfers.

GTRSOCW=GTRSOCW;

? Define the implicit rate for Social welfare transfers.

RGTRSOCW=GTRSOCW/(PCONS*N);
print RGTRSOCW;

? Define social insurance fund deficit (GTRSOCDF).

GTRSOCDF=GTRSOCW-GTYSOC;

? Transfers to agriculture

GTRA=GTRA;
RGTRA=GTRA/OAV;

? Other dometic transfer payments

GTRO=GTRO;
RGTRO=GTRO/(PCONS*N);
print RGTRO;

? Total transfers

GTR= GTRNDI+GTRU+GTRSOCW+GTRA+GTRO;
```

```
? Total current public expenditure (GEXPC)

GEXPC=YWG_GFS+GENW_GFS+GTR;
print GEXPC;

? EXTRACT: Total government capital expenditure

GEK=GEK;
print GEK;

? Calculate residual GTRK

GTRK=GEK-IGV;
print GEK, IGV, GTRK;

? Total public expenditure (current plus capital)

GEXP=GEXPC+GEK;

? Check total public expenditure against the GFS statistics


? -------------------------------------------
? Define public sector borrowing requirement
? Current (GBORC) and total (GBOR)
? -------------------------------------------

GBORC = GEXPC-GREV;

GBOR   = GEXP-GREV;

? Set exogenous version of national debt (GNDTG)
? for use in policy feed-back rule

GND=GND;
GNDEX=GND;
GNDTG=GND;

DUMGND=0;

SMPL 1987 2006;

? ------------------------------------
? Construction of GDP at market prices
? ------------------------------------

? Derive GDP residual (expenditure minus production).

STATDISV=GDPEV-GDPFCV;
STATDIS=GDPE-GDPFC;
print GDPEV, STATDISV;
print GDPE, STATDIS;

RSDIS=100*STATDIS/GDPE;
RSDISV=100*STATDISV/GDPEV;
print RSDIS, RSDISV;

GDPMV=GDPFCV+STATDISV;
GDPM=GDPFC+STATDIS;

GDPMDOT  = 100*(GDPM/GDPM(-1)-1);
PGDPM    = GDPMV/GDPM;
PGDPMDOT = 100*(PGDPM/PGDPM(-1)-1);

print GDPMDOT,PGDPMDOT;

? Define overall public expenditure and tax ratios

GEXPRAT=100*GEXP/GDPMV;
GREVRAT=100*GREV/GDPMV;

? Investment ratios

IGDPRAT = 100*IV/GDPEV;

RIGV=IGV/GDPEV;
```

```
? Derivation of household disposable income

DEPRT=DEPRT;
DEPRAT=DEPRT/(PI*(KT+KN+KBC+KA));
RDEP=100*DEPRT/GDPFCV;
print DEPRAT RDEP;

? Net domestic product at factor cost (note subsidies assumed zero)

NDPFCV = GDPMV-DEPRT-GTE;

? Set YFN=0 initially, pending insertion of a BOP mechanism

YFN=0.0;

? Net national product at factor cost

NNPFCV=NDPFCV+YFN;

? Set GTTI (public sector trading and investment income) to zero

GTTI=0;

? Private income

YP=NNPFCV-GTTI+GTR;

? Define aggregate rate of personal (non-corporate) taxation (RGTY)

YC=NDPFCV-YW;
YCRAT=100*YC/GDPFCV;
print YCRAT;

RGTYC=GTYC/YC(-1);
print RGTYC;

? Undistributed profits - no data available
? In absence of data, assume 30% profits undistributed

YCURAT=0.30;
YCU=YCURAT*YC;
YPER=YP-YCU;

? Define personal disposable income by netting off direct tax paid
? by the personal (non-corporate) sector (GTY).

YPERD=YPER-(GTYP+GTYSOCW);

YRPERD=YPERD/PCONS;
YRPERDPC=YRPERD/N;
SAV=YPERD-CONSV;
SAVRAT=100*SAV/YPERD;
print SAVRAT;

? Average non-agricultural annual earnings

WNA=YWNA/(LTEMP+LLNEMP+LBCEMP+LG);
WNADOT=100*(WNA/WNA(-1)-1);

? Average economy-wide productivity

LPROD=GDPFC/L;
LPRODDOT=100*(LPROD/LPROD(-1)-1);


ONA=OT+ON+OBC+OG;
OPNA=OT+ON+OBC;
POPNA=(OTV+ONV+OBCV)/(OT+ON+OBC);
POPNADOT=100*(POPNA/POPNA(-1)-1);
YWPNA=YWT+YWN+YWBC;
WPNA=(YWT+YWN+YWBC)/(LTEMP+LLNEMP+LBCEMP);
RWPNA=WPNA/PCONS;
RWPNADOT=100*(RWPNA/RWPNA(-1)-1);
LPRPNA=(OT+ON+OBC)/(LT+LLN+LBC);
ULCPNA=(YWT+YWN+YWBC)/(OT+ON+OBC);

? Note that the definition of the wedge  and the
```

```
? real wage after tax and social security payments in
? the T-sector  has changed.

WEDGE=(1+RGTYP+RGTYSOCW)*(1+RGTE);
RATWT=WT*(1-RGTYP-RGTYSOCW)/PCONS;

print RGTE, WEDGE, RATWT;


NTSVR=100*(NTSV/GDPEV);
GBORCR=100*(GBORC/GDPEV);
GBORR=100*GBOR/GDPEV;

print NTSV GBOR ;
print NTSVR, GBORR ;

RDEBT=100*GND/GDPEV;
print RDEBT;

? Add in the CSF variables as zero for the present

DETANPH=0.0;
DETANPI=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;

TRINDP=0.0;
TRINEC=0.0;
TRINPR=0.0;

TRITDP=0.0;
TRITEC=0.0;
TRITPR=0.0;

TRIADP_E=0.0;
TRIAEC_E=0.0;
TRIAPR_E=0.0;

TRINDP_E=0.0;
TRINEC_E=0.0;
TRINPR_E=0.0;

TRITDP_E=0.0;
```

```
TRITEC_E=0.0;
TRITPR_E=0.0;

TRIN=0.0;
TRINEOT=0.0;
TRIT=0.0;
TRITEOT=0.0;
TRIA=0.0;
TRIAEOT=0.0;

CSFTRAN=0.0;
CSFTRANR=0.0;

GECSFRA0=0.0;
GECSFRAT=0.0;
GECSFRA2=0.0;
GECSFRA3=0.0;
GECSFT=0.0;
GECSF2=0.0;
GECSF3=0.0;
GECSFTR=0.0;

GECSF=0;
GECSFDP=0;
GECSFE=0;
GECSFEC=0;
GECSFEC_E=0;
GECSFP=0;
GECSFRAE=0;
GECSFRAP=0;

TRIDP=0.0;
TRIEC=0.0;

GTRSF=0.0;

IGVCSF=0.0;

KSFTRAIN=0.0;
KTRAIN=(9*0.54*0.0 + 4*0.31*1.0 + 2*0.03*1.0 + 4*0.12*1.0)*LF;
KTRAIN0=KTRAIN;
KTRNR=1.0;

KT0=KT;
KTR=KT/KT0;
KN0=KN;
KNR=KN/KN0;

LINS=0.0;
SFTRAIN=0.0;
SFWAG=0.0;

WTRAIN=0.25*WT;

KGINF0=KGINF;
KGINFR=KGINF/KGINF0;
GDPEV0=GDPEV;

CSFTRNEC=0.0;
CSFTRNDP=0.0;
CSFECR=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;

? ----------------------------------------------------------
? Set ANX, ATX  to the calibrated AN and AT CES parameters
? ----------------------------------------------------------

ATX = 5.44211;
ANX = 8.99953;
```

```
? Miscellaneous print-outs;

print LPRT, LPRN, LPRBC, LPRA;
print LSHRT, LSHRN, LSHRBC, LSHRA;
print WT, WN, WBC, WA, WG;
print WTDOT, WNDOT, WBCDOT, WADOT, WGDOT;

LTRAT=100*(LT/L);
LLNRAT=100*(LLN/L);
LGRAT=100*(LG/L);
LARAT=100*(LA/L);
LBCRAT=100*(LBC/L);
print LTRAT LLNRAT LGRAT LARAT LBCRAT GTYP GTYC GTYW GTYSOCE GTYSOCW;
print GTEVAT GTEX GTEM GTEO GREVO YWG_GFS GENW_GFS GEK GTRNDI GTRSOCW GTRU GTRA GTRO;
print GTRK GV IGV GND;

END;
```

A3.4 Dump of Data for WINSOLVE HTR5 Model Database: HTR5.SDF

```
? ----------------------------------------------------------------
?
?                      HTR5_WINSOLVE.TSP
?
? TSP batch file to transfer all the historical data variables
? to WINSOLVE-readable XLS fileS (HTR5_EXOG.XLS, HTR5_ENDOG01.XLS,
? HTR5_ENDOG02.XLS)

?               Last modified: December 5, 2008
? ----------------------------------------------------------------

IN HTR5DB;

FREQ A;
SMPL 1987,2006;

WRITE(FILE='C:\SIM\HTR5\HTR5_EXOG.XLS')


DEPRAT,
DETANPH, DETANPI, DETATPH, DETATPI, DETATQH, DETATQI,
DUMGND,

GECSFEC_RE, GNDEX,GTRK,GTRSFPR,GTTI,
IGV, IGVCSFPR, IH, IHV,
LG,N,NELD,NWORK,OGNW,
POA,PMEUR, RDCOFIN,RGENW,RGREVO,RGTEM,RGTEO,RGTEVAT,RGTEX,
RGTRA,RGTRNDI,RGTRO,RGTRSF,RGTRSOCW,RGTYC,RGTYPEX,RGTYSOCE,RGTYSOCW,RGTYW,
RIGVCSF,RRSA,RTRIT,SEARAT,SEBCRAT,SENRAT,SETRAT,
STATDIS,STATDISV,T,TBC,TFRACT,TKA,TLA,TLFPR,TM,TN,TOA,TOBC,TON,TOT,
TRIADP,TRIAEC,TRIAPR,TRINPR,TRITPR,
TT,TX,WIGME,WIOME,
YCURAT,YFN,
BEEUR   BEP     DEEUR   DEP     ESEUR   ESP     FREUR   FRP
IPCTP1  IPCTP2  IPCTP3  IPCTP4  IPCTP5
IPCTP6  IPCTP7  IPCTP8  IPCTP9  ITEUR   ITP
MCTP1   MCTP2   MCTP3   MCTP4   MCTP5   MCTP6   MCTP7   MCTP8   MCTP9
MWP1    MWP2    MWP3    MWP4    MWP5    MWP6
NLEUR   NLP     SEEUR   SEP
UKEUR   UKP     UR_ALT  USEUR
USP     XW01    XW02    XW03    XW04    XW05    XW06    XW07
XW08    XW09    XWP1 XWP2 XWP3 XWP4 XWP5 XWP6            TREUR
;


WRITE(FILE='C:\SIM\HTR5\HTR5_ENDOG01.XLS')

ANX,ATX,CONS,CONSV,CSFTRAN,CSFTRANR,DEPRT,DS,DSV,ERFPBC,ERFPN,ERFPT,FD,FDON,
FDOT,G,GBOR,GBORR,GDA,GDPE,GDPEDOT,GDPEV,GDPEV0,GDPFC,GDPFCDOT,GDPFCPC,GDPFCV,
GDPM,GDPMDOT,GDPMV,GECSF,GECSFDP,GECSFE,GECSFEC,GECSFEC_E,GECSFP,GECSFRA0,
GECSFRAE,GECSFRAP,GECSFRAT,GECSFT,GECSFTR,GEK,GENW,GENW_GFS,GEXP,GEXPC,GND,GREV,GREVO,
GREVTAX,GTE,GTEM,GTEO,GTEVAT,GTEX,GTR,GTRA,GTRNDI,GTRO,
GTRSF, GTRSFDP,GTRSFEC,GTRSOCDF,GTRSOCW,GTRU,GTY,GTYC,GTYP,GTYSOC,GTYSOCE,
GTYSOCW,GTYW,GV,GV_GFS,I,IA,IAV,IBC,IBCTOT,IG,IGINF,IGINFBC,IGINFME,
IGINFV,IGVCSF,IGVCSFDP,IGVCSFEC,IMETOT,IN,INH,INV,IOTH,IOTHBC,IOTHME,
IP,IPV,IT,ITV,IV,KA,KBC,KGINF,KGINF0,KGINFR,KN,KN0,KNR,KP,KSFTRAIN,KT,KT0,
KTR,KTRAIN,KTRAIN0,KTRNR

;


WRITE(FILE='C:\SIM\HTR5\HTR5_ENDOG02.XLS')

L,LA,LAEMP,LASEMP,LBC,LBCEMP,LBCSEMP,LF,LFPR,LINS,LLN,LLNEMP,LLNSEMP,LNA,LPNA,
LPRBC,LPRN,LPROD,LPRODDOT,LPRPNA,LPRT,LSHRBC,LSHRN,LSHRT,LT,LTEMP,LTSEMP,
M,MV,NDEP,NDPFCV,NJUV,NNPFCV,NTS,NTSV,NTSVR,
OA,OAV,OBC,OBCV,OG,OGNWV,OGV,ON,ONA,ONV,OT,OTV,OWIP,OWM,PCOMPT,PCONS,PCONSDOT,
PG,PGDPFC,PGDPFCDT,PGDPM,PI,PIA,PIAGG,PIBC,PIG,PIN,PIT,PKBC,PKN,
PKT,PM,POBC,POG,PON,POPNA,POPNADOT,POT,POTDOT,PUK,PUS,PWORLD,PX,PXDOT,
RATWT,RDEBT,RFPBC,RFPN,RFPT,RGTE,RGTRU,RGTYP,RULCT,RWPNA,RWPNADOT,
SAV,SAVRAT,SFTRAIN,SFWAG,ST,TRIA,TRIAEOT,TRIDP,TRIEC,TRIN,TRINDP,TRINEC,
TRINEOT,TRIT,TRITDP,TRITEC,TRITEOT,U,ULCBC,ULCN,ULCPNA,ULCT,UR,URBAR,URP,
WA, WADOT,WBC,WBCDOT,WEDGE,WG, WN,WNA,WNADOT,WNDOT,WPNA,WT,WTDOT,WTRAIN,
```

```
X,XV,YC,YCA,YCBC,YCN,YCT,YCU,YP,YPER,YPERD,YRPERD,YRPERDPC,YW,YWA,YWBC,
YWG,YWG_GFS,YWN,YWNA,YWPNA,YWT,
PDE PITA PFR PES PNL PBE
PSE    PUK    PUS

;


END;
```

Appendix 4: TSP Model Calibration Batch Files

A4.1 Joint factor demand systems: T, N and BC

```
? ------------------------------------------------------------
?    Calibrate joint factor demand system in manufacturing
?
?            Last modified: December 5, 2008
? ------------------------------------------------------------

in HTR5DB;
OPTIONS LIMWARN=1;

? ------------------------------------------------
?              CES version for T-sector
? ------------------------------------------------

print IT LT OT ERFPT;

? Check full sample size

smpl 2001 2006;

y1=log(it/lt);
x1=log(erfpt);
title "CES for manufacturing (unconstrained) with/without time";
olsq y1 c x1 t;
olsq y1 c x1;

? ------------------------------------------------

param sigt rhot delt;
set z1=@coef(1);
set z2=@coef(2);
set sigt = z2;
set rhot = (1-sigt)/sigt;
set delt = 1/(1+exp(z1/sigt));
print sigt rhot delt;


temp1=-rhot*log(LT);
temp1=exp(temp1);
temp2=-rhot*log(IT);
temp2=exp(temp2);
temp=delt*temp1+(1-delt)*temp2;
temp=(-1/rhot)*log(temp);
temp=exp(temp);
y1=log(OT)-log(temp);

Title "Recover remaining CES parameters (AT, LAMT) for T-sector";
olsq y1 c t;

set z3=@coef(1);
set z4=@coef(2);
param at lamt;
set at=exp(z3);
set lamt=z4;
Title "=====================================================";
print sigt rhot delt at lamt;
Title "=====================================================";

delete z1 z2 z3 z4;

? ------------------------------------------------------

y1=log(it/lt);
x1=log(erfpt);
```

```
? -----------------------------------------------------
? Now constrain SIGT to be 0.20 (i.e., near Leontief)
? -----------------------------------------------------

set sigt = 0.20;
y2=y1-sigt*x1;
title "CES for manufacturing: constrained SIGT (0.20)";
olsq y2 c;
set z1=@coef(1);
set rhot = (1-sigt)/sigt;
set delt = 1/(1+exp(z1/sigt));
print sigt rhot delt;

temp1=-rhot*log(LT);
temp1=exp(temp1);
temp2=-rhot*log(IT);
temp2=exp(temp2);
temp=delt*temp1+(1-delt)*temp2;
temp=(-1/rhot)*log(temp);
temp=exp(temp);

y1=log(OT)-log(temp);
Title "Recover remaining CES parameters for T-sector: AT, LAMT";
olsq y1 c t;
set z3=@coef(1);
set z4=@coef(2);
param at lamt;
set at=exp(z3);
set lamt=z4;
Title "==================================================";
print sigt rhot delt at lamt;
Title "==================================================";

delete z1 z2 z3 z4;

? ----------------------------------------------------

y1=log(it/lt);
x1=log(erfpt);

? ----------------------------------------------------------------
? Constrain SIGT to be 0.50 (i.e., between Leontief & Cobb-Douglas
? ----------------------------------------------------------------

set sigt = 0.50;
y2=y1-sigt*x1;
title "CES for manufacturing: constrained SIGT (0.50)";
olsq y2 c;
set z1=@coef(1);
set rhot = (1-sigt)/sigt;
set delt = 1/(1+exp(z1/sigt));
print sigt rhot delt;

temp1=-rhot*log(LT);
temp1=exp(temp1);
temp2=-rhot*log(IT);
temp2=exp(temp2);
temp=delt*temp1+(1-delt)*temp2;
temp=(-1/rhot)*log(temp);
temp=exp(temp);

y1=log(OT)-log(temp);
Title "Recover remaining CES parameters for T-sector: AT, LAMT";
olsq y1 c t;
set z3=@coef(1);
set z4=@coef(2);
param at lamt;
set at=exp(z3);
set lamt=z4;

Title "==================================================";
print sigt rhot delt at lamt;
Title "==================================================";

delete z1 z2 z3 z4;

? ----------------------------------------------------
```

```
y1=log(it/lt);
x1=log(erfpt);

? -------------------------------------------------------
? Constrain SIGT to be 0.80 (i.e., quasi Cobb-Douglas).
? -------------------------------------------------------

set sigt = 0.80;
y2=y1-sigt*x1;
title "CES for manufacturing: constrained SIGT (0.80)";
olsq y2 c;
set z1=@coef(1);
set rhot = (1-sigt)/sigt;
set delt = 1/(1+exp(z1/sigt));
print sigt rhot delt;


temp1=-rhot*log(LT);
temp1=exp(temp1);
temp2=-rhot*log(IT);
temp2=exp(temp2);
temp=delt*temp1+(1-delt)*temp2;
temp=(-1/rhot)*log(temp);
temp=exp(temp);

y1=log(OT)-log(temp);
Title "Recover remaining CES parameters for T-sector: AT, LAMT";
olsq y1 c t;
set z3=@coef(1);
set z4=@coef(2);
param at lamt;
set at=exp(z3);
set lamt=z4;

Title "=========================================================";
print sigt rhot delt at lamt;
Title "=========================================================";

delete z1 z2 z3 z4;

END ;


? ----------------------------------------------------------------
?   Calibrate joint factor demand system in market services
?
?               Last modified: December 5, 2008
? ----------------------------------------------------------------

in HTR5DB;
OPTIONS LIMWARN=1;

? -------------------------------------------
?        CES version for N-sector
? -------------------------------------------

print IN, LLN, ON, ERFPN;

smpl 1987 2006;

y1=log(in/LLN);
x1=log(erfpn);
title "CES for market services: unconstrained SIGN";
olsq y1 c x1 t;
olsq y1 c x1;

?
? Note that SIGN is a reserved word within TSP, but not within
? WINSOLVE.  Hence, within HERJFDCN, we use SIGNN.
?

param signn rhon deln;
set z1=@coef(1);
set z2=@coef(2);
set signn = z2;
set rhon = (1-signn)/signn;
```

```
set deln = 1/(1+exp(z1/signn));
print signn rhon deln;

temp1=-rhon*log(LLN);
temp1=exp(temp1);
temp2=-rhon*log(IN);
temp2=exp(temp2);
temp=deln*temp1+(1-deln)*temp2;
temp=(-1/rhon)*log(temp);
temp=exp(temp);
y1=log(ON)-log(temp);

Title "Recover remaining CES parameters (AN, LAMM) for N-sector";
olsq y1 c t;

set z3=@coef(1);
set z4=@coef(2);
param an lamn;
set an=exp(z3);
set lamn=z4;
Title "========================================================";
print signn rhon deln an lamn;
Title "========================================================";

delete z1 z2 z3 z4;


? ----------------------------------------------------------------------
? Constrain SIGNN to be 0.50 (i.e., between Cobb-Douglas) and Leontief
? ----------------------------------------------------------------------

y1=log(in/lln);
x1=log(erfpn);

set signn = 0.50;
y2=y1-signn*x1;
title "CES for market services: constrained SIGN (0.50)";
olsq y2 c;
set z1=@coef(1);
set rhon = (1-signn)/signn;
set deln = 1/(1+exp(z1/signn));
print signn rhon deln;


temp1=-rhon*log(LLN);
temp1=exp(temp1);
temp2=-rhon*log(IN);
temp2=exp(temp2);
temp=deln*temp1+(1-deln)*temp2;
temp=(-1/rhon)*log(temp);
temp=exp(temp);

y1=log(ON)-log(temp);
Title "Recover remaining CES parameters for N-sector: AN, LAMN";
olsq y1 c t;
set z3=@coef(1);
set z4=@coef(2);
param an lamn;
set an=exp(z3);
set lamn=z4;

Title "============================================================";
print signn rhon deln an lamn;
Title "============================================================";

delete z1 z2 z3 z4;


? ----------------------------------------------------------
? Constrain SIGNN to be 0.80 (i.e., quasi Cobb-Douglas).
? ----------------------------------------------------------

y1=log(in/lln);
x1=log(erfpn);

set signn = 0.80;
y2=y1-signn*x1;
```

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```
title "CES for market services: constrained SIGN (0.80)";
olsq y2 c;
set z1=@coef(1);
set rhon = (1-signn)/signn;
set deln = 1/(1+exp(z1/signn));
print signn rhon deln;


temp1=-rhon*log(LLN);
temp1=exp(temp1);
temp2=-rhon*log(IN);
temp2=exp(temp2);
temp=deln*temp1+(1-deln)*temp2;
temp=(-1/rhon)*log(temp);
temp=exp(temp);

y1=log(ON)-log(temp);
Title "Recover remaining CES parameters for N-sector: AN, LAMN";
olsq y1 c t;
set z3=@coef(1);
set z4=@coef(2);
param an lamn;
set an=exp(z3);
set lamn=z4;

Title "=============================================================";
print signn rhon deln an lamn;
Title "=============================================================";

delete z1 z2 z3 z4;



END ;



? --------------------------------------------------------------
?     Calibrate joint factor demand system in B&C
?
?            Last modified: December 5, 2008
? --------------------------------------------------------------

in HTR5DB;
OPTIONS LIMWARN=1;

? ---------------------------------------------------
?               CES version for BC-sector
? ---------------------------------------------------

print IBC LBC OBC ERFPBC;

? Check full sample size

smpl 1987 2006;

y1=log(ibc/lbc);
x1=log(erfpbc);
title "CES for B&C sector (unconstrained) with/without time";
olsq y1 c x1 t;
olsq y1 c x1;

? ---------------------------------------------------

param sigbc rhobc delbc;
set z1=@coef(1);
set z2=@coef(2);
set sigbc = z2;
set rhobc = (1-sigbc)/sigbc;
set delbc = 1/(1+exp(z1/sigbc));
print sigbc rhobc delbc;


temp1=-rhobc*log(LBC);
temp1=exp(temp1);
temp2=-rhobc*log(IBC);
temp2=exp(temp2);
```

```
temp=delbc*temp1+(1-delbc)*temp2;
temp=(-1/rhobc)*log(temp);
temp=exp(temp);
y1=log(OBC)-log(temp);

Title "Recover remaining CES parameters (ABC, LAMBC) for BC-sector";
olsq y1 c t;

set z3=@coef(1);
set z4=@coef(2);
param abc lambc;
set abc=exp(z3);
set lambc=z4;
Title "========================================================";
print sigbc rhobc delbc abc lambc;
Title "========================================================";

delete z1 z2 z3 z4;

? ------------------------------------------------------

y1=log(ibc/lbc);
x1=log(erfpbc);

? ----------------------------------------------------------
? Now constrain SIGBC to be 0.50 (i.e., between Leontief & CD)
? ----------------------------------------------------------

set sigbc = 0.50;
y2=y1-sigbc*x1;
title "CES for B&C sectgor: constrained SIGBC (0.50)";
olsq y2 c;
set z1=@coef(1);
set rhobc = (1-sigbc)/sigbc;
set delbc = 1/(1+exp(z1/sigbc));
print sigbc rhobc delbc;

temp1=-rhobc*log(LBC);
temp1=exp(temp1);
temp2=-rhobc*log(IBC);
temp2=exp(temp2);
temp=delbc*temp1+(1-delbc)*temp2;
temp=(-1/rhobc)*log(temp);
temp=exp(temp);

y1=log(OBC)-log(temp);
Title "Recover remaining CES parameters for B&C-sector: ABC, LAMBC";
olsq y1 c t;
set z3=@coef(1);
set z4=@coef(2);
param abc lambc;
set abc=exp(z3);
set lambc=z4;
Title "========================================================";
print sigbc rhobc delbc abc lambc;
Title "========================================================";

delete z1 z2 z3 z4;

? ----------------------------------------------------

y1=log(ibc/lbc);
x1=log(erfpbc);

? -------------------------------------------------------
? Now constrain SIGBC to be 0.80 (i.e., near Cobb-Douglas)
? -------------------------------------------------------

set sigbc = 0.80;
y2=y1-sigbc*x1;
title "CES for B&C sectgor: constrained SIGBC (0.80)";
olsq y2 c;
set z1=@coef(1);
set rhobc = (1-sigbc)/sigbc;
set delbc = 1/(1+exp(z1/sigbc));
print sigbc rhobc delbc;
```

```
temp1=-rhobc*log(LBC);
temp1=exp(temp1);
temp2=-rhobc*log(IBC);
temp2=exp(temp2);
temp=delbc*temp1+(1-delbc)*temp2;
temp=(-1/rhobc)*log(temp);
temp=exp(temp);

y1=log(OBC)-log(temp);
Title "Recover remaining CES parameters for B&C-sector: ABC, LAMBC";
olsq y1 c t;
set z3=@coef(1);
set z4=@coef(2);
param abc lambc;
set abc=exp(z3);
set lambc=z4;
Title "=========================================================";
print sigbc rhobc delbc abc lambc;
Title "=========================================================";

delete z1 z2 z3 z4;

? -------------------------------------------------------

END ;
```

A4.2 Calibration of Remaining Behavioural Equations

```
? -----------------------------------------------------------
? TSP batch file to calibrate all of HTR5, excluding the
? joint factor demand equations.

? Complete re-calibration of equations used in HTR5

? Update and re-run after and data or model change

?          Last modified: December 5, 2008
? -----------------------------------------------------------

? Access the HTR5 database (HTR5DB.TLB)

IN HTR5DB;

? Store the "actual" and "predicted" vaues in HTR5PLOTDB.TLB
? These are for use in drawing graphs for papers

OUT HTR5PLOTDB;

OPTIONS LIMERR=10 LIMWARN=1 LIMWNUMC=1;

? -----------------------------------------------------------
? -----------------------------------------------------------

SMPL 1988 2006;

? --------------------------------------
? OT: GDP arising in manufacturing sector -
? --------------------------------------

print X M GDPM;
smpl 1988 2006;
XSHR=X/(GDPFC+M);
print XSHR;
MSD XSHR;

? ----------------------------------------

y1=log(ot);
x1=log(owm);
x2=log(ulct/pot);
x3=log(fdot);
x4=log(pot/pworld);

title " Free Calibration: OT reg on OWM,ULCT/POT,FDOT,POT/PWORLD and T";
olsq y1 c x1 x2 x3 x4 t;

y1=log(ot/fdot);
x1=log(owm/fdot);
x2=log(ulct/pot);

title "OLS OT reg on OWM, FDOT, RULCT: log-lin-Restricted";
olsq y1 c x1 x2;
title "AR1 OT reg on OWM, FDOT, RULCT: log-lin-Restricted";
ar1  y1 c x1 x2;

title "AR1 OT reg on OWM, FDOT, RULCT: log-lin-Restricted";
ar1  y1 c x1 x2 t;

title "OT on OWM,ULCT/POT(-0.25),FDOT,POT/PWORLD(-0.25)and T";
y1=log(ot);
x1=log(owm);
x2=log(ulct/pot);
x3=log(fdot);
x4=log(pot/pworld);

y2=y1+0.25*x2+0.25*x4;
y3=y2-x3;
x5=x1-x3;
smpl 1995 2006;
ols y3 c x5 t;
```

```
temp=@fit;
temp=temp-0.25*x2-0.25*x4;
temp=exp(temp);
OTP=FDOT*temp;
OT=OT;
OTPPER=100*(OTP-OT)/OT;

print OT, OTP, OTPPER;

smpl 1988 2006;

?-----------------------------------------------------------
? POTEQ: Deflator of GDP in manufacturing -----------------
?-----------------------------------------------------------

y1=log(pot/ulct);
x1=log(pworld/ulct);

?title "OLS POT on PWORLD and ULCT: homogeneity imposed";
?olsq y1 c x1;
Title "AR1 POT on PWORLD and ULCT: homogeneity imposed ";
ar1  y1 c x1;

y2=y1-0.7*x1;
title "OLS POT on PWORLD (0.7) and ULCT (0.3)";
olsq y2 c;

temp=@fit;
temp=temp+0.4*x1;
temp=exp(temp);
POTP=temp*ULCT;
POTPDOT=100*(POTP/POTP(-1)-1);
POTDOT=POTDOT;
POTPDOTER=POTPDOT-POTDOT;

print POTDOT, POTPDOT, POTPDOTER;

? ---------------------- ------
? WT: Wage rate in manufacturing
? ----------------------------

print WT POT WEDGE LPRT URBAR;

y1=log(wt/pot);
x1=log(wedge);
x2=log(LPRT);

z1=log(wt/pcons);
w1=log(wedge);
w2=log(LPRT);

Title "OLS WT/POT on LPRT, URBAR";
olsq y1 c x2 urbar;
Title "OLS WT/PCONS on LPRT, URBAR";
olsq z1 c w2 urbar;

title "AR1 WT/POT on LPRT, URBAR";
ar1  y1 c x2 urbar;
title "AR1 WT/PCONS on LPRT, URBAR";
ar1  z1 c w2 urbar;


y2=y1+0.01*urbar;
z2=z1+0.01*urbar;

smpl 1988 2006;
Title "1988-2006: OLS WT/POT on LPRT, URBAR (-0.01): constrained";
olsq y2 c x2 ;
ar1  y2 c x2;
Title "1988-2006: OLS WT/PCONS on LPRT, URBAR (-0.01): constrained";
olsq z2 c w2 ;
ar1  z2 c w2 ;

smpl 1995 2006;
Title "1995-2006: OLS WT/POT on LPRT, URBAR (-0.01): constrained";
olsq y2 c x2 ;
```

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```
Title "1995-2006: OLS WT/PCONS on LPRT, URBAR (-0.01): constrained";
olsq z2 c w2 ;
ar1  z2 c w2;

smpl 1988 2006;
y2=y1+0.01*urbar-1.0*x2;
z2=z1+0.01*urbar-1.0*w2;

smpl 1988 2006;
Title "OLS WT/POT on LPRT(1.0), URBAR (-0.01): constrained";
olsq y2 c  ;
Title "OLS WT/PCONS on LPRT(1.0), URBAR (-0.01): constrained";
olsq z2 c  ;
smpl 1995 2006;
Title "OLS WT/POT on LPRT(1.0), URBAR (-0.01): constrained";
olsq y2 c  ;
Title "OLS WT/PCONS on LPRT(1.0), URBAR (-0.01): constrained";
olsq z2 c  ;


temp=@fit;
temp=temp-0.01*urbar+1.0*w2;
temp=exp(temp);
WTP=temp*PCONS;
WTPDOT=100*(WTP/WTP(-1)-1);
WTDOT=WTDOT;
WTPDOTER=WTPDOT-WTDOT;

print WTDOT, WTPDOT, WTPDOTER;

print POTDOT PCONSDOT WTDOT;


?---------------------------------------------------------
? ONEQ: GDP arising in market services --------------------
?---------------------------------------------------------

y1=log(ON);
x1=log(FDON);

title "OLS ON on FDON, t: log-linear";
olsq y1 c x1 t;
title "AR1 ON on FDON, t: log-linear";
ar1  y1 c x1 t;

ONP=exp(@fit);
ON=ON;
ONPPER=100*(ONP-ON)/ON;

print ON, ONP, ONPPER;

?---------------------------------------------------------
? PONEQ: Deflator of GDP arising in market services -------
?---------------------------------------------------------

print PONDOT;

y1=log(pon/ulcn(-1));
x1=log(ulcn/ulcn(-1));

title "OLS PON on ULCN, ULCN(-1): log-lin";
olsq y1 c x1;
title "AR1 PON on ULCN, ULCN(-1): log-lin";
ar1  y1 c x1;

smpl 1995 2006;
title "OLS PON on ULCN, ULCN(-1): log-lin";
olsq y1 c x1;
title "AR1 PON on ULCN, ULCN(-1): log-lin";
ar1  y1 c x1;

temp=@fit;
temp=exp(temp);
PONP=temp*ULCN(-1);;
PONPDOT=100*(PONP/PONP(-1)-1);
PONDOT=PONDOT;
PONPDOTER=PONPDOT-PONDOT;
```

```
print PONDOT, PONPDOT, PONPDOTER;

smpl 1988 2006;


?-------------------------------------------------
? OBCEQ: GDP arising in B&C   --------------------
?-------------------------------------------------

y1=log(OBC);
x1=log(IBCTOT);

title "OLS OBC on IBCTOT, t: log-linear";
olsq y1 c x1 t;
title "AR1 OBC on IBCTOT, t: log-linear";
ar1  y1 c x1 t;

OBCP=exp(@fit);
OBC=OBC;
OBCPPER=100*(OBCP-OBC)/OBC;

print OBC, OBCP, OBCPPER;

?---------------------------------------------------
? POBCEQ: Deflator of GDP arising in B&C    -------
?---------------------------------------------------

y1=log(pobc/ulcbc(-1));
x1=log(ulcbc/ulcbc(-1));

title "OLS POBC on ULCBC, ULCBC(-1): log-lin";
olsq y1 c x1;
title "AR1 POBC on ULCBC, ULCBC(-1): log-lin";
ar1  y1 c x1;

temp=@fit;
temp=exp(temp);
POBCP=temp*ULCBC(-1);;
POBCPDOT=100*(POBCP/POBCP(-1)-1);
POBCDOT=POBCDOT;
POBCPDTE=POBCPDOT-POBCDOT;

print POBCDOT, POBCPDOT, POBCPDTE;


?------------------------------------------------------------
? OAEQ: GDP arising in ag., forestry & fishing ------------
?------------------------------------------------------------

y1=log(oa/la);

title "OLS OA/LA on T";
olsq y1 c t;
title "AR1 OA/LA on T";
ar1  y1 c t;

smpl 1996 2006;

title "OLS OA/LA on T";
olsq y1 c t;
title "AR1 OA/LA on T";
ar1  y1 c t;

temp=@fit;
temp=exp(temp);
OAP=temp*LA;
OA=OA;
OAPPER=100*(OAP-OA)/OA;

print OA, OAP, OAPPER;

smpl 1988 2006;

?------------------------------------------------------------
? LAEQ: numbers employed in ag., forestry & fishing -------
?------------------------------------------------------------
```

```
y1=log(la);

title "OLS LA on T";
olsq y1 c t;
title "AR1 LA on T";
ar1  y1 c t;

smpl 1996 2006;

title "OLS LA on T";
olsq y1 c t;
title "AR1 LA on T";
ar1  y1 c t;

LAP=exp(@fit);
LA=LA;
LAPPER=100*(LAP-LA)/LA;

print LA, LAP, LAPPER;

smpl 1988 2006;

?----------------------------------------------------------
? KAEQ: Fixed investment in ag., forestry & fishing -------
?----------------------------------------------------------

y1=log(ka/oa);

title "OLS KA/OA on T";
olsq y1 c t;
title "AR1 KA/OA on T";
ar1  y1 c t;

temp=@fit;
temp=exp(temp);
KAP=temp*OA;
KA=KA;
KAPPER=100*(KAP-KA)/KA;

print KA, KAP, KAPPER;


?----------------------------------------------------------
? LFPREQ: Labour force participation rate -----------------
?----------------------------------------------------------

title "ZZZ LFPR on T";
olsq lfpr c t;

LFPRP=@fit;
LFPR=LFPR;
LFPRPPER=100*(LFPRP-LFPR)/LFPR;

print LFPR, LFPRP, LFPRPPER;


?----------------------------------------------------------
? CONSEQ: Private (household) consumption -----------------
?----------------------------------------------------------

print CONS, YRPERD;

title "OLS CONS on YRPERD: linear";
olsq cons c yrperd;
title "AR1 CONS on YRPERD: linear";
ar1  cons c yrperd ;

smpl 1989 2006;
title "OLS CONS on YRPERD: linear";
olsq cons c yrperd;
title "AR1 CONS on YRPERD: linear";
ar1  cons c yrperd ;

smpl 1990 2006;
title "OLS CONS on YRPERD: linear";
olsq cons c yrperd;
```

```
title "AR1 CONS on YRPERD: linear";
ar1  cons c yrperd ;

smpl 1991 2006;
title "OLS CONS on YRPERD: linear";
olsq cons c yrperd;
title "AR1 CONS on YRPERD: linear";
ar1  cons c yrperd ;

smpl 1992 2006;
title "OLS CONS on YRPERD: linear";
olsq cons c yrperd;
title "AR1 CONS on YRPERD: linear";
ar1  cons c yrperd ;

smpl 1993 2006;
title "OLS CONS on YRPERD: linear";
olsq cons c yrperd;
title "AR1 CONS on YRPERD: linear";
ar1  cons c yrperd ;

smpl 1994 2006;
title "OLS CONS on YRPERD: linear";
olsq cons c yrperd;
title "AR1 CONS on YRPERD: linear";
ar1  cons c yrperd ;

CONSP=@fit;
CONS=CONS;
CONSPPER=100*(CONSP-CONS)/CONS;

print CONS, CONSP, CONSPPER;


?--------------------------------------
? MEQ: Total imports   -----------------
?--------------------------------------
smpl 1988 2006;
y1=log(M);
x1=log(FD);
x2=log(PM/POT);

title "OLS M on FD, PM/POT, t: log-linear";
olsq y1 c x1 x2 t;
title "AR1 M on FD, PM/POT, t: log-linear";
ar1  y1 c x1 x2 t;

y2=y1-x1;

title "OLS M/FD on PM/POT, t: log-linear";
olsq y2 c x2 t;

temp=@fit;
temp=temp+x1;
MP=exp(temp);
M=M;
MPPER=100*(MP-M)/M;

print M, MP, MPPER;


?--------------------------------------
? XEQ: Total exports   -----------------
?--------------------------------------
y1=log(X);
x1=log(OWM);
x2=log(ULCT/POT);

title "OLS X on OWM, ULCT/POT, t: log-linear";
olsq y1 c x1 x2 t;
title "AR1 X on OWM, ULCT/POT, t: log-linear";
ar1  y1 c x1 x2 t;

y1=log(X/OWM);
x1=log(ULCT/POT);

title "OLS X/OWM regr on ULCT/POT, t: log-linear";
```

```
olsq y1 c x1 t;
title "AR1 X/OWM regr on ULCT/POT, t: log-linear";
ar1  y1 c x1 t;

y1=log(X);
x1=log(OT);
x2=log(ULCT/POT);

title "OLS X regr on OT, ULCT/POT, t: log-linear";
olsq y1 c x1 x2 t;

y2=y1-x1;

title "OLS X/OT regr on ULCT/POT, t: log-linear";
olsq y2 c x2 t;
title "OLS X/OT regr on ULCT/POT, t: log-linear";
ar1 y2 c x2 t;

temp=@fit;
temp=exp(temp);
XP=OT*temp;
X=X;
XPPER=100*(XP-X)/X;

print X, XP, XPPER;


?----------------------------------------------------------
? PIEQ: Deflator of total fixed investment ----------------
?----------------------------------------------------------

y1=log(pi/pm);
x1=log(pgdpfc/pm);

title "OLS PI on PGDPFC,PM: log-lin";
olsq y1 c x1;
title "AR1 PI on PGDPFC,PM: log-lin";
ar1  y1 c x1;

smpl 1991 2006;
title "OLS PI on PGDPFC,PM: log-lin";
olsq y1 c x1;
title "AR1 PI on PGDPFC,PM: log-lin";
ar1  y1 c x1;

temp=@fit;
temp=exp(temp);
PIP=temp*PM;
PIPDOT=100*(PIP/PIP(-1)-1);
PIDOT=PIDOT;
PIPDOTER=PIPDOT-PIDOT;

print PIDOT, PIPDOT, PIPDOTER;

smpl 1988 2006;

?----------------------------------------------------------
? PCONSEQ: Deflator of private (household) consumption ----
?----------------------------------------------------------

y1=log(pcons/pm);
x1=log(pgdpfc/pm);
y2=y1-1.0*RGTE;

title "OLS PCONS on PGDPFC, PM and RGTE(1.0 imposed)";
olsq y1 c x1;
title "AR1 PCONS on PGDPFC, PM and RGTE(1.0 imposed)";
ar1  y2 c x1;

temp=@fit;
temp=temp+RGTE;
temp=exp(temp);
PCONSP=temp*PM;
PCONSPDT=100*(PCONSP/PCONSP(-1)-1);
PCONSDT=PCONSDOT;
PCONSPDE=PCONSPDT-PCONSDT;
```

```
print PCONSDT, PCONSPDT, PCONSPDE;




?--------------------------------------------
? PXEQ: Deflator of exports   ---------------
?--------------------------------------------

PWORLDDT=100*(PWORLD/PWORLD(-1)-1);

print PXDOT PGDPFCDT PWORLDDT;

y1=log(px/pworld);
x1=log(pgdpfc/pworld);

title "OLS PX on PGDPFC,PWORLD: log-lin";
olsq y1 c x1;
title "AR1 PX on PGDPFC,PWORLD: log-lin";
ar1  y1 c x1;

y2=y1-0.2*x1;
title "OLS PX on PGDPFC (0.2),PWORLD (0.8): log-lin";
olsq y2 c;

temp=@fit;
temp=temp+0.2*x1;
temp=exp(temp);
PXP=temp*PWORLD;
PXPDOT=100*(PXP/PXP(-1)-1);
PXDOT=PXDOT;
PXPDOTER=PXPDOT-PXDOT;

print PXDOT, PXPDOT, PXPDOTER;




? -------------------------------------
? Summary printout of actual vs predicted
? -------------------------------------

TITLE "Summary printout of actual vs predicted";

smpl 1988 2006;

print OT OTP OTPPER;
print POTDOT POTPDOT POTPDOTER;
print WTDOT WTPDOT WTPDOTER;
print ON ONP ONPPER;
print PONDOT PONPDOT PONPDOTER;
print OBC OBCP OBCPPER;
print POBCDOT POBCPDOT POBCPDTE;
print OA OAP OAPPER;
print LA LAP LAPPER;
print KA KAP KAPPER;
print LFPR LFPRP LFPRPPER;
print CONS CONSP CONSPPER;
print M, MP, MPPER;
print X, XP, XPPER;
print PIDOT PIPDOT PIPDOTER;
print PCONSDT, PCONSPDT, PCONSPDE;
print PXDOT PXPDOT PXPDOTER;

? -------------------------------------

END
```

Appendix 5: WINSOLVE Model Simulation Files

A5.1 Residual checking

```
WinSolve log file
@
@ ---------------------
@ Open the model HTR5.TXT
@ ---------------------
@
ModelOpen C:\sim\HTR5\HTR5.txt
@
@ ------------------------------------------------------------------
@ Open the database, HTR5.SDF (actual 1987-2004; missing 2005-2020)
@ ------------------------------------------------------------------
@
DataOpen C:\sim\HTR5\HTR5.sdf
@
@ -------------------------------------------
@ Set the solution algorithm options (Newton)
@ -------------------------------------------
@
SolveOpt alg Newton itmax 100 itp 100 maxerr 10 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 KGINF0  2
Alt KN0     2
Alt KT0     2
Alt KTRAIN0 2
@
SolveRun Run1 per 1992-2006 single
@
@ ----------------------------------------------------------
@ 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 KGINF0  2
Alt KN0     2
Alt KT0     2
Alt KTRAIN0 2
@
SolveRun Run2  per 1992-2006 dynsys noragged
@
EndLog
```

A5.2 PROD0: Projecting exogenous variables

```
WinSolve log file
@ Last modified: May 14, 2009
@ -------------------
@ Open model HTR5.TXT
@ -------------------
@
ModelOpen C:\sim\HTR5\HTR5.txt
@
@ --------------------------------------------------------------
@ Open the database, HTR5.SDF (actual 1987-2006; missing 2007-20)
@ --------------------------------------------------------------
@
DataOpen C:\sim\HTR5\HTR5.sdf
@
@ ------------------------------------------
@ Set the solution algorithm options (Newton)
@ ------------------------------------------
@
SolveOpt alg Newton itmax 100 itp 100 maxerr 10 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 KGINF0  2
Alt KN0     2
Alt KT0     2
Alt KTRAIN0 2
@
SolveRun Run1 per 1996-2006 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 KGINF0  2
Alt KN0     2
Alt KT0     2
Alt KTRAIN0 2
@
SolveRun Run2 per 1996-2006 dynsys noragged
@
@ Note: Run2 should reproduce the within sample historical data
@
@ ---------------------------------------------------------------------------------------
@ -------------     Project the exogenous variables from 2007 to 2020     ----------------
@ ---------------------------------------------------------------------------------------
@
@ TRENDS: Project time trend terms at specific out-of-sample rates
@ LFPR WAS INCREASED.
@ TREND RISE IN OA/LA WAS DECREASED.
@ TREND RISE IN LFPR WAS INCREASED.
@ IGV WAS INCREASED.
@ RGTYPEX WAS DECREASED STARTING FROM 2010.
@ RGTEX WAS DECREASED STARTING FROM 2016.
@ TREND FALL IN LA WAS DECREASED.
DataProj T        per 2007-2020 cnst 20.0  trnd 1.00  { }
@
DataProj TOT      per 2007-2007 cnst 20.0  trnd 3.0  {Trend rise in OT:      0.6% pa}
DataProj TOT      per 2008-2008 cnst 23.0  trnd 0.0 {Trend rise in OT:      0.6% pa}
DataProj TOT      per 2009-2009 cnst 23.0  trnd -10.00  {Trend rise in OT:      0.6% pa}
```

```
DataProj TOT        per 2010-2010 cnst 13.0   trnd 1.00   {Trend rise in OT:      0.6% pa}
DataProj TOT        per 2011-2011 cnst 14.0   trnd 0.50   {Trend rise in OT:      0.6% pa}
DataProj TOT        per 2012-2020 cnst 14.5   trnd 1.00   {Trend rise in OT:      0.6% pa}

DataProj TT         per 2007-2020 cnst 20.0   trnd 1.00   {Tech prog rise in TT:   1.9% pa}
DataProj TOBC       per 2007-2007 cnst 20.0   trnd -150    {Trend rise in OBC:     -0.024% pa}
DataProj TOBC       per 2008-2008 cnst -130.0  trnd 300    {Trend rise in OBC:      -0.024% pa}
DataProj TOBC       per 2009-2009 cnst 170.0  trnd 210    {Trend rise in OBC:     -0.024% pa}
DataProj TOBC       per 2010-2010 cnst 380.0  trnd -50    {Trend rise in OBC:     -0.024% pa}
DataProj TOBC       per 2011-2011 cnst 330.0  trnd -100    {Trend rise in OBC:      -0.024% pa}
DataProj TOBC       per 2012-2020 cnst 230.0  trnd -50    {Trend rise in OBC:     -0.024% pa}

DataProj TBC        per 2007-2020 cnst 20.0   trnd 1.00   {Tech prog rise in TBC:  0.599% pa}
DataProj TON        per 2007-2007 cnst 20.0   trnd 1.6    {Trend rise in TON:     2.76% pa}
DataProj TON        per 2008-2008 cnst 21.6   trnd 0.2    {Trend rise in TON:     2.76% pa}
DataProj TON        per 2009-2009 cnst 21.8   trnd -0.20   {Trend rise in TON:      2.76% pa}
DataProj TON        per 2010-2010 cnst 21.6   trnd 0.6    {Trend rise in TON:     2.76% pa}
DataProj TON        per 2011-2020 cnst 22.2   trnd 1.0    {Trend rise in TON:     2.76% pa}

DataProj TN         per 2007-2020 cnst 20.0   trnd 5.00   {Tech prog rise in TN:   0.19% pa}
DataProj TLFPR      per 2007-2007 cnst 20.0   trnd -0.1   {Trend in LFPR:         -0.58 %pts pa }
DataProj TLFPR      per 2008-2008 cnst 19.9   trnd -0.2   {Trend in LFPR:         -0.58 %pts pa }
DataProj TLFPR      per 2009-2020 cnst 19.7   trnd 0.0    {Trend in LFPR:         -0.58 %pts pa }

DataProj TOA        per 2007-2007 cnst 20.0   trnd -1.0   {Trend rise in OA/LA:    4.9% pa}
DataProj TOA        per 2008-2008 cnst 19.0   trnd 0.50   {Trend rise in OA/LA:    4.9% pa}
DataProj TOA        per 2009-2009 cnst 19.5   trnd 0.30   {Trend rise in OA/LA:    4.9% pa}
DataProj TOA        per 2010-2010 cnst 19.8   trnd 0.0    {Trend rise in OA/LA:    4.9% pa}
DataProj TOA        per 2011-2020 cnst 19.8   trnd 0.70   {Trend rise in OA/LA:    4.9% pa}

DataProj TLA        per 2007-2007 cnst 20.0   trnd 0.40   {Trend decline in LA:   -4.0% pa}
DataProj TLA        per 2008-2010 cnst 20.4   trnd -0.4   {Trend decline in LA:   -4.0% pa}
DataProj TLA        per 2011-2020 cnst 19.2   trnd 0.40   {Trend decline in LA:   -4.0% pa}

DataProj TKA        per 2007-2020 cnst 20.0   trnd 1.00   {Trend rise in KA/OA:    3.4% pa }
DataProj TM         per 2007-2007 cnst 20.0   trnd 0.6    {Trend rise in imports:  4.7% pa}
DataProj TM         per 2008-2008 cnst 20.6   trnd -1.2   {Trend rise in imports:  4.7% pa}
DataProj TM         per 2009-2009 cnst 19.4   trnd -2.0   {Trend rise in imports:  4.7% pa}
DataProj TM         per 2010-2010 cnst 17.4   trnd 0.5    {Trend rise in imports:  4.7% pa}
DataProj TM         per 2011-2020 cnst 17.9   trnd 0.2    {Trend rise in imports:  4.7% pa}

DataProj TX         per 2007-2007 cnst 20.0   trnd 0.0    {Trend rise in exports:  5.5% pa}
DataProj TX         per 2008-2008 cnst 20.0   trnd 0.5    {Trend rise in exports:  5.5% pa}
DataProj TX         per 2009-2009 cnst 20.5   trnd 0.0    {Trend rise in exports:  5.5% pa}
DataProj TX         per 2010-2010 cnst 20.5   trnd 0.3    {Trend rise in exports:  5.5% pa}
DataProj TX         per 2011-2020 cnst 20.8   trnd 0.0    {Trend rise in exports:  5.5% pa}

@
@ Project external inflation at annual rate of 3.0 per cent
@
@ WORLD OUTPUT: Industrial output in main trading partners
@
DataProj IPCTP1    per 2007-2020 ldv 1.03
DataProj IPCTP2    per 2007-2020 ldv 1.03
DataProj IPCTP3    per 2007-2020 ldv 1.03
DataProj IPCTP4    per 2007-2020 ldv 1.03
DataProj IPCTP5    per 2007-2020 ldv 1.03
DataProj IPCTP6    per 2007-2020 ldv 1.03
DataProj IPCTP7    per 2007-2020 ldv 1.03
DataProj IPCTP8    per 2007-2020 ldv 1.03
DataProj IPCTP9    per 2007-2020 ldv 1.03
@
@ WORLD IMPORTS: Total imports of main trading partners
@
DataProj MCTP1     per 2007-2007 ldv 1.05
DataProj MCTP2     per 2007-2007 ldv 0.985
DataProj MCTP3     per 2007-2007 ldv 1.038
DataProj MCTP4     per 2007-2007 ldv 1.022
DataProj MCTP5     per 2007-2007 ldv 1.056
DataProj MCTP6     per 2007-2007 ldv 1.062
DataProj MCTP7     per 2007-2007 ldv 1.057
DataProj MCTP8     per 2007-2007 ldv 1.067
DataProj MCTP9     per 2007-2007 ldv 1.046
@
DataProj MCTP1     per 2008-2008 ldv 1.04
DataProj MCTP2     per 2008-2008 ldv 0.994
DataProj MCTP3     per 2008-2008 ldv 0.955
```

```
DataProj MCTP4   per 2008-2008 ldv 0.965
DataProj MCTP5   per 2008-2008 ldv 1.0
DataProj MCTP6   per 2008-2008 ldv 0.975
DataProj MCTP7   per 2008-2008 ldv 1.041
DataProj MCTP8   per 2008-2008 ldv 0.956
DataProj MCTP9   per 2008-2008 ldv 1.033
@
DataProj MCTP1   per 2009-2009 ldv 0.892
DataProj MCTP2   per 2009-2009 ldv 0.87
DataProj MCTP3   per 2009-2009 ldv 0.872
DataProj MCTP4   per 2009-2009 ldv 0.893
DataProj MCTP5   per 2009-2009 ldv 0.90
DataProj MCTP6   per 2009-2009 ldv 0.855
DataProj MCTP7   per 2009-2009 ldv 0.907
DataProj MCTP8   per 2009-2009 ldv 0.94
DataProj MCTP9   per 2009-2009 ldv 0.89
@
DataProj MCTP1   per 2010-2010 ldv 0.983
DataProj MCTP2   per 2010-2010 ldv 0.98
DataProj MCTP3   per 2010-2010 ldv 1.002
DataProj MCTP4   per 2010-2010 ldv 1.015
DataProj MCTP5   per 2010-2010 ldv 1.0
DataProj MCTP6   per 2010-2010 ldv 0.976
DataProj MCTP7   per 2010-2010 ldv 0.996
DataProj MCTP8   per 2010-2010 ldv 1.009
DataProj MCTP9   per 2010-2010 ldv 0.991
@
DataProj MCTP1   per 2011-2020 ldv 1.05
DataProj MCTP2   per 2011-2020 ldv 1.05
DataProj MCTP3   per 2011-2020 ldv 1.05
DataProj MCTP4   per 2011-2020 ldv 1.05
DataProj MCTP5   per 2011-2020 ldv 1.05
DataProj MCTP6   per 2011-2020 ldv 1.05
DataProj MCTP7   per 2011-2020 ldv 1.05
DataProj MCTP8   per 2011-2020 ldv 1.05
DataProj MCTP9   per 2011-2020 ldv 1.05
@
@ National currency rates against the euro
@
DataProj TREUR   per 2007-2020 ldv 1.0
@
DataProj BEEUR   per 2007-2020 ldv 1.0
DataProj DEEUR   per 2007-2020 ldv 1.0
DataProj ESEUR   per 2007-2020 ldv 1.0
DataProj FREUR   per 2007-2020 ldv 1.0
DataProj ITEUR   per 2007-2020 ldv 1.0
DataProj NLEUR   per 2007-2020 ldv 1.0
DataProj SEEUR   per 2007-2020 ldv 1.0
DataProj UKEUR   per 2007-2020 ldv 1.0
DataProj USEUR   per 2007-2020 ldv 1.0
@
@ Industrial output prices in main trading partners
@
DataProj BEP    per 2007-2020 ldv 1.02
DataProj DEP    per 2007-2020 ldv 1.02
DataProj ESP    per 2007-2020 ldv 1.02
DataProj FRP    per 2007-2020 ldv 1.02
DataProj ITP    per 2007-2020 ldv 1.02
DataProj NLP    per 2007-2020 ldv 1.02
DataProj SEP    per 2007-2020 ldv 1.02
DataProj UKP    per 2007-2020 ldv 1.02
DataProj USP    per 2007-2020 ldv 1.02
@
DataProj POA    per 2007-2020 ldv 1.02
@
@ DEMOGRAPHICS: Project population variables from 2007 to 2020
@
DataProj N       per 2007-2020 ldv  1.015
DataProj NWORK   per 2007-2020 ldv  1.015
DataProj NELD    per 2007-2020 ldv  1.015
@
@ ------------------------------------------------------------
@
DataProj DEPRAT   per 2007-2020 ldv 1.0
@
DataProj DETANPH  per 2007-2020 ldv 1.0
DataProj DETANPI  per 2007-2020 ldv 1.0
```

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```
DataProj DETATPH  per 2007-2020 ldv 1.0
DataProj DETATPI  per 2007-2020 ldv 1.0
DataProj DETATQH  per 2007-2020 ldv 1.0
DataProj DETATQI  per 2007-2020 ldv 1.0
@
DataProj DUMGND   per 2007-2020 ldv 0.0
DataProj GNDEX    per 2007-2020 ldv 1.0
@
DataProj GTRK     per 2007-2020 ldv 1.00
DataProj GTTI     per 2007-2020 ldv 1.00
@
DataProj IGV      per 2007-2008 ldv 1.08
DataProj IGV      per 2009-2010 ldv 1.0
DataProj IGV      per 2011-2020 ldv 1.06
@
DataProj IH       per 2007-2020 ldv 1.0
DataProj IHV      per 2007-2020 ldv 1.0
@
@ Increase public sector employment by 2 %
@
DataProj LG       per 2007-2020 ldv 1.02
@
DataProj OGNW     per 2007-2020 ldv 1.02
@
@ Project tax and expenditure rates
@
DataProj RGENW     per 2007-2020 ldv 1.02
DataProj RGREVO    per 2007-2020 ldv 1.0
DataProj RGTEM     per 2007-2020 ldv 1.0
DataProj RGTEO     per 2007-2020 ldv 1.0
DataProj RGTEVAT   per 2007-2020 ldv 1.0
DataProj RGTEX     per 2007-2020 ldv 1.0
DataProj RGTRA     per 2007-2020 ldv 1.0
DataProj RGTRNDI   per 2007-2020 ldv 1.0
DataProj RGTRO     per 2007-2020 ldv 1.03
DataProj RGTRSOCW  per 2007-2020 ldv 1.03
DataProj RGTYC     per 2007-2020 ldv 1.0
DataProj RGTYPEX   per 2007-2020 ldv 1.0
DataProj RGTYSOCE  per 2007-2020 ldv 1.0
DataProj RGTYSOCW  per 2007-2020 ldv 1.0
DataProj RGTYW     per 2007-2020 ldv 1.0
@
DataProj STATDIS  per 2007-2020 ldv 1.0
DataProj STATDISV per 2007-2020 ldv 1.0
@
DataProj RRSA     per 2007-2007 ldv 0.8
DataProj RRSA     per 2008-2008 ldv 1.6
DataProj RRSA     per 2009-2009 ldv 0.7
DataProj RRSA     per 2010-2020 ldv 0.96
@
@ Freeze the ratios of self-employed to total for all sectors
@
DataProj SEARAT  per 2007-2020 ldv 1.0
DataProj SEBCRAT per 2007-2020 ldv 1.0
DataProj SENRAT  per 2007-2020 ldv 1.0
DataProj SETRAT  per 2007-2020 ldv 1.0
@
DataProj TFRACT  per 2007-2020 ldv 1.0
@
DataProj TRITPR  per 2007-2020 ldv 1.0
DataProj TRINPR  per 2007-2020 ldv 1.0
DataProj TRIAEC  per 2007-2020 ldv 1.0
DataProj TRIADP  per 2007-2020 ldv 1.0
DataProj TRIAPR  per 2007-2020 ldv 1.0
@
DataProj GTRSFPR  per 2007-2020 ldv 1.0
DataProj IGVCSFPR per 2007-2020 ldv 1.0
@
DataProj GECSFEC_RE per 2007-2020 ldv 1.0
DataProj RDCOFIN    per 2007-2020 ldv 1.0
DataProj RIGVCSF    per 2007-2020 ldv 1.0
DataProj RGTRSF     per 2007-2020 ldv 1.0
DataProj RTRIT      per 2007-2020 ldv 1.0
@
DataProj WIGME   per 2007-2020 ldv 1.0
DataProj WIOME   per 2007-2020 ldv 1.0
@
```

```
@ Export shares
@
DataProj YCURAT   per 2007-2020 ldv 1.0
DataProj YFN      per 2007-2020 ldv 1.0
@
@ Export weights for definition of OWIP and OWM (fixed out of sample)
@
DataProj XW01   per 2007-2020 ldv 1.0
DataProj XW02   per 2007-2020 ldv 1.0
DataProj XW03   per 2007-2020 ldv 1.0
DataProj XW04   per 2007-2020 ldv 1.0
DataProj XW05   per 2007-2020 ldv 1.0
DataProj XW06   per 2007-2020 ldv 1.0
DataProj XW07   per 2007-2020 ldv 1.0
DataProj XW08   per 2007-2020 ldv 1.0
DataProj XW09   per 2007-2020 ldv 1.0
@
@ Weights for determining PWORLD (fixed out of sample)
@
DataProj XWP1   per 2007-2020 ldv 1.0
DataProj XWP2   per 2007-2020 ldv 1.0
DataProj XWP3   per 2007-2020 ldv 1.0
DataProj XWP4   per 2007-2020 ldv 1.0
DataProj XWP5   per 2007-2020 ldv 1.0
DataProj XWP6   per 2007-2020 ldv 1.0
@
@ Weights for endogenising PM (fixed out of sample)
@
DataProj MWP1   per 2007-2020 ldv 1.0
DataProj MWP2   per 2007-2020 ldv 1.0
DataProj MWP3   per 2007-2020 ldv 1.0
DataProj MWP4   per 2007-2020 ldv 1.0
DataProj MWP5   per 2007-2020 ldv 1.0
DataProj MWP6   per 2007-2020 ldv 1.0
@
@ ------------------------------------------------------------------------
@ Make projections of the implicit behavioural residuals (or adjustments)
@ ------------------------------------------------------------------------
@
AdjProj OT    per 2007-2020 ldv  1.0
AdjProj IT    per 2007-2020 ldv  1.0
AdjProj LT    per 2007-2020 ldv  1.0
AdjProj POT   per 2007-2020 ldv  1.0
AdjProj WT    per 2007-2020 ldv  1.0
@
AdjProj ON    per 2007-2020 ldv  1.0
AdjProj IN    per 2007-2020 ldv  1.0
AdjProj LLN   per 2007-2020 ldv  1.0
AdjProj PON   per 2007-2020 ldv  1.0
AdjProj WN    per 2007-2020      cnst 0.0
@
AdjProj OBC   per 2007-2020 ldv  1.0
AdjProj IBC   per 2007-2020 ldv  1.0
AdjProj LBC   per 2007-2020 ldv  1.0
AdjProj POBC  per 2007-2020 ldv  1.0
AdjProj WBC   per 2007-2020      cnst 0.0
@
AdjProj OA    per 2007-2020 ldv  1.0
AdjProj LA    per 2007-2020 ldv  1.0
AdjProj KA    per 2007-2020 ldv  1.0
AdjProj WA    per 2007-2020      cnst 0.0
AdjProj WG    per 2007-2020      cnst 0.0
@
AdjProj POG   per 2007-2020      cnst 0.0
@
AdjProj LFPR  per 2007-2020 ldv  1.0
@
AdjProj CONS  per 2007-2020 ldv  1.0
AdjProj M     per 2007-2020 ldv  1.0
AdjProj X     per 2007-2020 ldv  1.0
@
AdjProj PIAGG per 2007-2020 ldv  1.0
AdjProj PIT   per 2007-2020      cnst 0.0
AdjProj PIBC  per 2007-2020      cnst 0.0
AdjProj PIN   per 2007-2020      cnst 0.0
AdjProj PIA   per 2007-2020      cnst 0.0
AdjProj PIG   per 2007-2020      cnst 0.0
```

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```
AdjProj PCONS per 2007-2020 ldv  1.0
AdjProj PG    per 2007-2020      cnst 0.0
AdjProj PX    per 2007-2020 ldv  1.0
AdjProj PM    per 2007-2020 ldv  1.0
AdjProj PG    per 2007-2020      cnst 0.0
AdjProj RGTRU per 2007-2020      cnst 0.0
@
AdjSave C:\sim\HTR5\HTR5ADJP.sdf
@
@ ----------------------------------
@ Save projected data in HTR5PROD0.SDF
@ ----------------------------------
@
DataSave  C:\sim\HTR5\HTR5PROD0.sdf
@
EndLog
```

A5.3 PROD1: Baseline projection simulation

```
WinSolve log file
@
@ ------------------
@ Open model HTR5.TXT
@ ------------------
@
ModelOpen C:\sim\HTR5\HTR5.txt
@
@ -----------------------------------------------------------------
@ Open data file of historical 1987-2006 data, with exogenous
@ variables and adjustments projected to 2020 (from HTR5PROD0.LOG)
@ -----------------------------------------------------------------
@
DataOpen C:\sim\HTR5\HTR5PROD0.sdf
@
@ Set simulation algorithm to Newton, with tight convergence criteria
@
SolveOpt alg Newton itmax 1000 itp 500 maxerr 0 errval 1.0 abs 0.025 pct 0.025 alpha 1.0 beta 1.0
@
@ Dynamic projection from 1995 to 2020, using projected exogenous variables and adjustments
@
@ -----------------------------
Alt GDPEV0  2
Alt KGINF0  2
Alt KN0     2
Alt KT0     2
Alt KTRAIN0 2
@
SolveRun Run1  base per 1996-2020
@ -----------------------------
@
@ Run1 reproduces the within sample data for 96-06, and projects out of sample
@
@ Dynamic projection from 1996 to 2020, using simulated stocks
@ (KGINF0, KTRAIN0, KT0, KN0 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 KN0 Run1
Datareset KT0 Run1
Datareset KTRAIN0 Run1
Fix GDPEV0  per 1996-2020
Fix KGINF0  per 1996-2020
Fix KN0     per 1996-2020
Fix KT0     per 1996-2020
Fix KTRAIN0 per 1996-2020
Alt GDPEV0  1
Alt KGINF0  1
Alt KN0     1
Alt KT0     1
Alt KTRAIN0 1
@
SolveRun Run2  dynsys per 1996-2020
@
ViewNew
>
spread per 1995-2020 file c:\SIM\HTR5\HTR5_BASELINE.XLS
DSV      sol        Run1 Run1
GDPMV    sol        Run1 Run1
DS       sol        Run1 Run1
GDPM     sol%dif    Run1 Run1
GDPFC    sol%dif    Run1 Run1
OT       sol%dif    Run1 Run1
ON       sol%dif    Run1 Run1
OBC      sol%dif    Run1 Run1
OA       sol%dif    Run1 Run1
OG       sol%dif    Run1 Run1
```

```
LPROD     sol%dif     Run1 Run1
LPRT      sol%dif     Run1 Run1
LPRN      sol%dif     Run1 Run1
LPRBC     sol%dif     Run1 Run1
OA        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
LLN       sol%dif     Run1 Run1
LLN       sol         Run1 Run1
LBC       sol%dif     Run1 Run1
LBC       sol         Run1 Run1
LA        sol%dif     Run1 Run1
LA        sol         Run1 Run1
LG        sol%dif     Run1 Run1
LG        sol         Run1 Run1
CONS      sol%dif     Run1 Run1
I         sol%dif     Run1 Run1
G         sol%dif     Run1 Run1
X         sol%dif     Run1 Run1
M         sol%dif     Run1 Run1
WT        sol%dif     Run1 Run1
PCONS     sol%dif     Run1 Run1
POT       sol%dif     Run1 Run1
PON       sol%dif     Run1 Run1
PG        sol%dif     Run1 Run1
PGDPFC    sol%dif     Run1 Run1
ULCT      sol%dif     Run1 Run1
SAVRAT    sol         Run1 Run1
GBORR     sol         Run1 Run1
NTSVR     sol         Run1 Run1
RDEBT     sol         Run1 Run1
;
@
DataSave c:\sim\HTR5\HTR5BASE.SDF
@
EndLog
```

A5.4 A shock to world demand: OWM

```
WinSolve log file
@
@ Open model HTR5.TXT
@
ModelOpen C:\sim\HTR5\HTR5.TXT
@
@ Open data file of historical 87-2006 data, extended to 2020
@
DataOpen C:\sim\HTR5\HTR5BASE.sdf
@
@ Set simulation algorithm to Newton, with tight convergence criteria
SolveOpt alg Newton itmax 100 itp 100 maxerr 0 errval 1.000000 abs 0.001 pct 0.001 alpha 1.000000
beta 1.000000
@
@ Dynamic projection from 2006 to 2020, using projected exovars and adjs
@
Alt GDPEV0  2
Alt KGINF0  2
Alt KN0     2
Alt KT0     2
Alt KTRAIN0 2
@
SolveRun Run1  dynsys per 2006-2020
@
AdjProj MCTP1   per 2007-2020 cnst 0.1 mult
AdjProj MCTP2   per 2007-2020 cnst 0.1 mult
AdjProj MCTP3   per 2007-2020 cnst 0.1 mult
AdjProj MCTP4   per 2007-2020 cnst 0.1 mult
AdjProj MCTP5   per 2007-2020 cnst 0.1 mult
AdjProj MCTP6   per 2007-2020 cnst 0.1 mult
AdjProj MCTP7   per 2007-2020 cnst 0.1 mult
AdjProj MCTP8   per 2007-2020 cnst 0.1 mult
AdjProj MCTP9   per 2007-2020 cnst 0.1 mult
@
Alt GDPEV0  2
Alt KGINF0  2
Alt KN0     2
Alt KT0     2
Alt KTRAIN0 2
@
SolveRun Run2  dynsys per 2006-2020
@
@ --------------------------------------------
@ Write a standard set of output to an excel file
@ --------------------------------------------
@
ViewNew
>
spread per 2006-2020 file c:\SIM\HTR5\OWM_Impacts.xls
OWM    pct Latest Run1
OT     pct Latest Run1
ON     pct Latest Run1
OBC    pct Latest Run1
GDPFC pct Latest Run1
;
@
EndLog
```

A5.5 A shock to public sector employment: LG

```
WinSolve log file
@
@ Open model HTR5.TXT
@
ModelOpen C:\sim\HTR5\HTR5.TXT
@
@ Open data file of historical 87-2006 data, extended to 2020
@
DataOpen C:\sim\HTR5\HTR5BASE.sdf
@
@ Set simulation algorithm to Newton, with tight convergence criteria
@
SolveOpt alg Newton itmax 100 itp 100 maxerr 0 errval 1.000000 abs 0.001 pct 0.001 alpha 1.000000
beta 1.000000
@
@ Dynamic projection from 2006 to 2020, using projected exovars and adjs
@
Alt GDPEV0  2
Alt KGINF0  2
Alt KN0     2
Alt KT0     2
Alt KTRAIN0 2
@
SolveRun Run1  dynsys per 2006-2020
@
@ Make 10% increase to LG
@
AdjDefType int
AdjType LG mult
AdjProj LG per 2007-2020 cnst 0.100000
@
Alt GDPEV0  2
Alt KGINF0  2
Alt KN0     2
Alt KT0     2
Alt KTRAIN0 2
@
SolveRun Run2  dynsys per 2006-2020
@
@ -----------------------------------------------
@ Write a standard set of output to an excel file
@ -----------------------------------------------
@
ViewNew
>
spread per 2006-2020 file c:\SIM\HTR5\LG_Impacts.xls
LG     dif Latest Run1
LT     dif Latest Run1
LLN    dif Latest Run1
LBC    dif Latest Run1
L      dif Latest Run1
;
@
EndLog
```

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A5.6 A shock to public investment: IGV

```
WinSolve log file
@
@ Open model HTR5.TXT
@
ModelOpen C:\sim\HTR5\HTR5.TXT
@
@ Open data file of historical 87-2006 data, extended to 2020
@
DataOpen C:\sim\HTR5\HTR5BASE.sdf
@
@ Set simulation algorithm to Newton, with tight convergence criteria
@
SolveOpt alg Newton itmax 100 itp 100 maxerr 0 errval 1.000000 abs 0.001 pct 0.001 alpha 1.000000
beta 1.000000
@
@ Dynamic projection from 2006 to 2020, using projected exovars and adjs
@
Alt GDPEV0  2
Alt KGINF0  2
Alt KN0     2
Alt KT0     2
Alt KTRAIN0 2
@
SolveRun Run1  dynsys noragged per 2006-2020
@
AdjDefType int
AdjType IGV mult
AdjProj IGV per 2007-2020 cnst 0.100000
@
Alt GDPEV0  2
Alt KGINF0  2
Alt KN0     2
Alt KT0     2
Alt KTRAIN0 2
@
SolveRun Run2  dynsys noragged per 2006-2020
@
@ -------------------------------------------
@ Write a standard set of output to an excel file
@ -------------------------------------------
@
ViewNew
>
spread per 2006-2020 file c:\SIM\HTR5\IGV_Impacts.xls
IG      dif Latest Run1
I       dif Latest Run1
CONS    dif Latest Run1
X       dif Latest Run1
M       dif Latest Run1
NTS     dif Latest Run1
GDPE    dif Latest Run1
;
@
EndLog
```

A5.7 A shock to all exogenous prices

```
WinSolve log file
@
@ ----------------------------------------------------------
@      Shock to all external prices (PWORLD and POA)
@ ----------------------------------------------------------
@
@ Open model HTR5.TXT
@
ModelOpen C:\SIM\HTR5\HTR5.txt
@
@ Open data file of historical 1987-2006 data, with exovars and
@ adjustments projected to 2020
@
DataOpen C:\SIM\HTR5\HTR5BASE.sdf
@
@ Set simulation algorithm to Newton, with tight convergence criteria
@
SolveOpt alg Newton itmax 100 itp 100 maxerr 0 errval 1.0 abs 0.001 pct 0.001 alpha 1.0 beta 1.0
@
@ Dynamic projection from 2006 to 2020, using projected exovars and adjs
@
Alt KGINF0    2
Alt KTRAIN0   2
Alt GDPEV0    2
Alt KN0       2
Alt KT0       2
@
SolveRun Run1  dynsys per 2006-2020
@
AdjDefType int
AdjType DEP mult
AdjDefType int
AdjType ITP mult
AdjDefType int
AdjType FRP mult
AdjDefType int
AdjType ESP mult
AdjDefType int
AdjType NLP mult
AdjDefType int
AdjType BEP mult
AdjDefType int
AdjType UKP mult
AdjDefType int
AdjType SEP mult
AdjDefType int
AdjType USP mult
AdjDefType int
AdjType POA mult
@
AdjProj DEP  per 2007-2020 cnst 0.100000
AdjProj ITP  per 2007-2020 cnst 0.100000
AdjProj FRP  per 2007-2020 cnst 0.100000
AdjProj ESP  per 2007-2020 cnst 0.100000
AdjProj NLP  per 2007-2020 cnst 0.100000
AdjProj BEP  per 2007-2020 cnst 0.100000
AdjProj UKP  per 2007-2020 cnst 0.100000
AdjProj SEP  per 2007-2020 cnst 0.100000
AdjProj USP  per 2007-2020 cnst 0.100000
AdjProj POA  per 2007-2020 cnst 0.100000
@
Alt KGINF0    2
Alt KTRAIN0   2
Alt GDPEV0    2
Alt KN0       2
Alt KT0       2
@
SolveRun Run2  dynsys per 2006-2020
@
@ ------------------------------------------------
@ Write a standard set of output to an excel file
```

```
@ ----------------------------------------------
@
ViewNew
>
spread per 2006-2020 file c:\SIM\HTR5\PWORLD_Impacts.xls
PWORLD    pct Latest Run1
PM        pct Latest Run1
POT       pct Latest Run1
PON       pct Latest Run1
PGDPFC    pct Latest Run1
PCONS     pct Latest Run1
WT        pct Latest Run1
ULCT      pct Latest Run1
RULCT     pct Latest Run1
;
@
EndLog
```