Modelling EU accession and Structural Fund impacts using the new Polish HERMIN model

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[1] Introduction

The term *cohesion* has been used to describe the process of convergence of the geographically peripheral and poorer member states of the EU (mainly Greece, Ireland, Portugal and Spain) to a level of development and a standard of living approximately equal to that pertaining in the wealthier core member states. The term *transition*, on the other hand, is used to describe the process of transforming the previously centrally planned socialist economies of Central and Eastern Europe into open liberalised market economies. These two processes have some differences, but many similarities.

When one tackles the task of analysing and modelling a transition economy, it is important to distinguish two different phases of the process. The first phase is associated with the early stages of transition and addresses such questions as privatisation, disorganisation, reallocation and restructuring. Such processes are unique to economies emerging from central planning in that they have only very limited counterparts or analogues in developed liberal market economies.[1]

The second phase concerns the later stages of transition and assumes that the previously centrally planned economy has gone through a necessary critical mass of institutional and structural reforms which makes it appropriate to apply fairly standard macroeconomic concepts and theories commonly used for the analysis of developing market economies. However, the construction of suitable models using historical data is a difficult task in light of the very rapid pace of institutional and structural change and the rather limited set of data usually available. In addition to modelling the recent past of the transition economies, model builders interested in studying the second phase of transition need to look to the future as well as the past, and to consider the type of economic structure towards which convergence may be still be taking place.

The later stages of the process of transition in the CEE countries (i.e., the stages following after the initial breakdown in centrally planned economic activities and the dramatic restructuring and evolution of market-based economic institutions) will require accelerated rates of growth and development if catch-up with EU standards of living is to take place within a reasonable time period. This process of catch-up has interesting similarities with the cohesion (or real convergence) process already under way in the periphery of the EU.

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

[1] The approach to the disorganisation stage of transition is documented in Aghion and Blanchard (1994), Blanchard (1997) and Kremer and Blanchard (1997).

The inspiration for the initial work on the present model of Poland comes from the earlier EU cohesion country models, since the structural changes presently taking place in Poland have clear similarities to those occurring now in the EU cohesion countries and regions. One must recognise that it is a fact of life that the economic turmoil of the early stages of CEE transition is more amenable to *qualitative* rather than *quantitative* analysis, although some quantitative analysis is possible (Blanchard, 1997). However, by the mid-1990s the processes of change in countries like Poland had become somewhat more predictable as new institutions and policies based on market economics gradually replaced the central-planning of the earlier era and as generally steadier growth resumed from a lower base level of activity after initial severe downward adjustments. Hence, a *quantitative* exploration of the impacts of policy decisions, against the background of a progressively stabilising economic system, has now become both desirable and feasible.

Formal models of different types can go some way towards assisting the realisation of transition analysis. For example, static computable general equilibrium (CGE) models have been used to study the Slovenian transition (Potocnik and Majcen, 1996). However, there are a number of issues for which dynamic neo-Keynesian macro-sectoral economic models provide a more suitable vehicle for analysis and this motivated the development and use of HERMIN-type models for a range of CEE economies.[2]

The economic development and convergence questions that preoccupy the EU periphery and the CEE economies can benefit from explicit treatment of aspects such as disequilibria, dynamics, policy feedbacks, expectations and growth processes. Our modelling approach for Poland addresses some of this agenda by constructing a small, carefully designed, structural empirical macro model capable of handling disequilibria, but keeping in mind the need to study medium-term development and transformation. Such a framework was motivated by the HERMIN models of the EU periphery (Bradley, Herce and Modesto, 1995e) that drew on earlier work on the EU HERMES system of models (d'Alcantara and Italianer, 1982).

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

In this paper we describe the development of a small-scale macromodel of the Polish economy the construction of which is intended as the first stage of a wider research agenda on modelling Poland at the national and regional levels as well as inter-country comparative work. The paper is structured as follows. Some of the main aspects of transitional development within Poland during the 1990s are described in section 2, making use of the

[2] See Kejak and Vavra (1999) for the Czech Republic; Ciupagea and Manda (1999) for Romania; Simoncic *et al.* (1999) for Slovenia; Bradley, Kearney and Morgenroth (2000) for Latvia; Bradley, Morgenroth and Untiedt (2000) for the former East Germany; Bradley, Kangur and Kearney (2001). An overview of this work is available in Barry and Bradley (1999) and Bradley (2000).

database that has been developed for the HERMIN model. Some background to the theoretical underpinnings and assumptions used by the HERMIN modelling framework, are presented in section 3. In section 4 we describe how we attempted to calibrate the model's behavioural equations using Polish national accounting and other data from the period 1994-2001. In section 5 we describe how the model was implemented, tested, and used to prepare a preliminary stylised baseline projection for the Polish economy out to the year 2010, using the WINSOLVE modelling software developed by Pierse, 1998. This baseline projection is then used to subject the model to a series of policy and other shocks designed to explore its behavioural responses. In section 6 we illustrate how the model was used to explore the likely impacts of the Polish National Development Plan2004-06, an integrated programme of public and private sector investment that will be accompanied by significant EU co-funding aid. Section 7 concludes and outlines the future Polish HERMIN modelling agenda.

[2] Transition and recovery in Poland: an overview

The opportunities offered by the Polish economy today stem from the political changes introduced in 1989 and the widespread economic reforms initiated in 1990. These reforms achieved many successes, such as:

i. Increased production levels (oriented both to exports and to domestic consumption)

ii. Significantly reduced inflation

iii. Made the zloty a convertible currency

iv. Increased foreign reserves

v. Liberalized prices

vi. Encouraged the growth of the private sector

vii. Obtained a reduction of foreign debt with creditors

viii. Reduced the dependence on the public sector in general.

This section presents an overview of the transition process in the Polish economy throughout the 1990s and into the early 2000s. The data used covers the period 1994 to 2001. The focus is on the supply-side of the economy, looking at the composition of output and employment by sector, the evolution of wages and prices and the degree of openness of the economy. Analysis is based on variables included in the HERMIN database for Poland. Because of the short time span of the data the implied trends must be interpreted with care.

2.1 GDP and income per capita

We take into the consideration four sectors: manufacturing, market services, agriculture and the public, or non-market sector. GDP at market prices is the sum of output produced in Poland, including net taxes on products, decreased by adjustments for financial services. GDP is presented in constant prices so as we obtain real GDP. Figure 2.1 shows that since the mid 1990s the Polish economy has been expanding at a fairly rapid pace. The economy experienced GDP growth throughout the 1994-2001 period showing strong increases from 1994-1997 then slower gains from 1998-2001. The slower GDP growth from 1998 to 2001 largely reflects the steps taken to cool down the economy and unfavorable external developments. The Polish economy slowed in 1998 as a result of the Asian and Russian crisis, and the sharp increase in international oil prices was another drag on economic growth. In 1999 GDP growth was led by domestic demand which grew faster than GDP. In 2000, mainly due to tight monetary policy, the growth of domestic demand slowed to 2.8%. Figure 2.2 shows that the average GDP growth for Poland during the 1995-2000 period was about 5,5%. In comparison, the average GDP growth in the Czech Republic was 1,8%, and Hungary 3,6%.

Over the same period the population in Poland did not significantly change, so Figure 2.3 shows that the GDP per capita curve correlates closely with the real GDP pattern. GDP per capita in Poland is growing, with the gap between Poland and EU Member States steadily narrowing.

Figure 2.1.

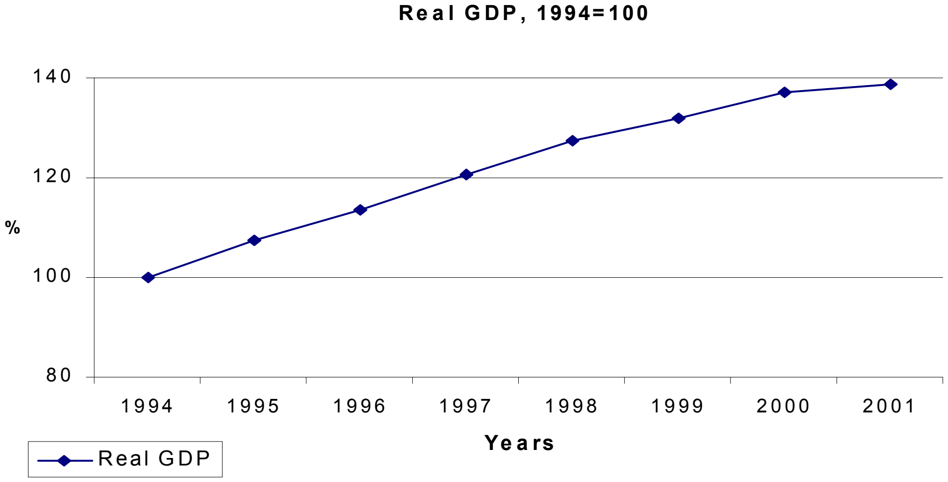
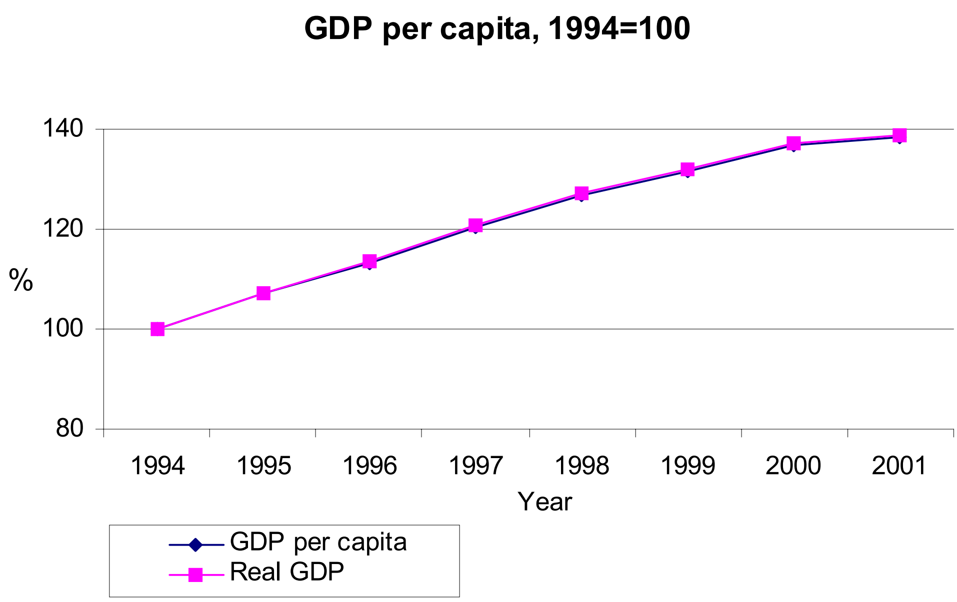


Figure 2.2.

Source: PAIZ

Figure 2.3.



The growth in GDP per capita can be broken down into, growth in productivity and economic dependency as follows:

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

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

Economic dependency can be further 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 GDP per capita growth from 1995 to 2001. It also includes the breakdown of GDP per capita growth into contribution from productivity, employment, participation and age dependency respectively. Average living standards have risen since 1995. In 1999 and 2000 strong productivity growth was offset by a fall in employment, so in 1999 the growth in GDP per capita was almost half the growth in productivity. In 2000 growth in GDP per capita was about two thirds of that in productivity. By contrast, from 1995 to 1998 strong growth in productivity was translated directly into strong growth of living standards. Throughout the period gradual changes in the age structure of the population have given a further small contribution to the growth of living standards. In 2001 we observe a significant fall both in productivity growth and GDP per capita growth.

Overall the cumulative increase in GDP per worker between 1995 and 2001 was over 33% while the increase in living standards was 2% less. During the period, the lowest GDP per worker growth and GDP per capita growth occurred in 2001. The fall in employment rate from 1999, led to increase the economic dependency of population. This relationship is shown in the Table 2.1.

Figure 2.4.

Decomposition of growth in GDP per capita

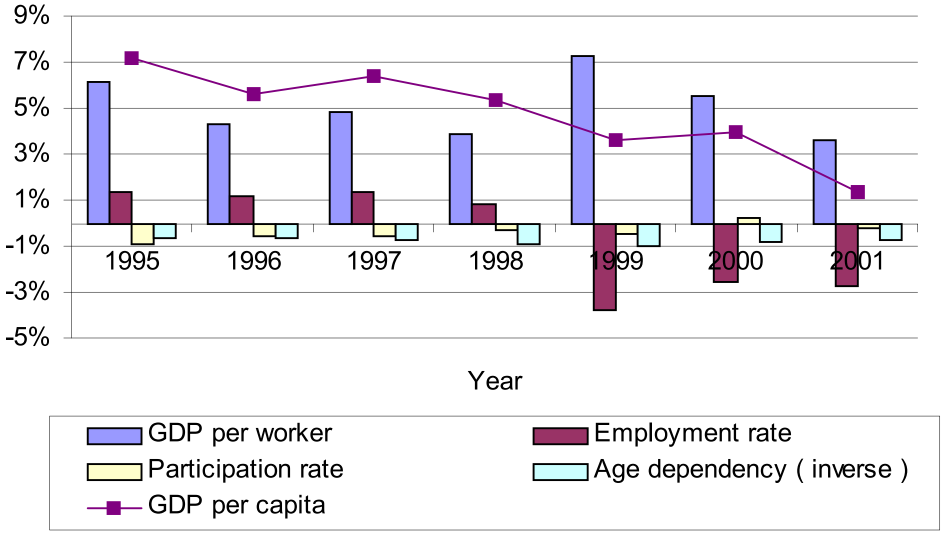


Table 2.1. Breakdown of Cumulative Growth in GDP per capita [%]

		GDP per capita		Economic Dependency		
Years	GDP per capita	Productivity	Economic Dependency	Employment Rate	Participation	Age Dependency
1995-2001	33.44	35.44	-1.76	-4.33	-2.93	5.49

2.2 Employment and unemployment

Total employment grew during the 1994 to 1998 period. But Figure 2.5 shows that it started to fall from 1999, and this trend has continued into 2001. From 1994 to 1996 we observe the highest share of unemployment benefit recipients in the registered unemployed. This was about 50% in 1994, reached almost 59% in 1995 and approximately 48% in 1996. Figure 2.5 also shows that from 1997 there is a marked reduction in this index.

The unemployment rate steadily fell from 1994 to 1998, but the trend reversed in 1999 when the unemployment rate amounted to 14,1% in 1999 and was 18,5% by 2001. This could be attributed to a weaker foreign demand and the ensuing slowdown of economic activity, especially in the industrial sector. However, the year 1999 also saw a rise in economic activity, coupled with a sizeable net increase in the age of the working population, and a restructuring process throughout a number of industries. At the end of 2001, a total of 3,115 thousand people were registered as jobless. Unemployment in Poland is mainly of a structural nature and it stems from changes in the economic environment. To some extent unemployment is also determined by demographic factors and unemployment also differs from one voivodship (region) to another. Figure 2.6 shows the unemployment rate trend from 1994 to 2001.

Figure 2.5.

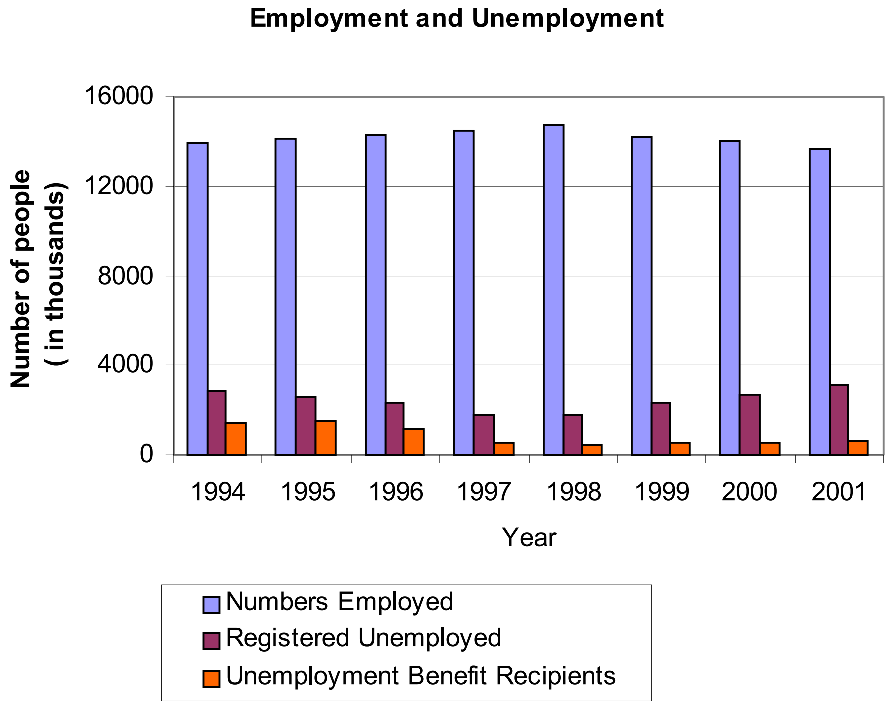
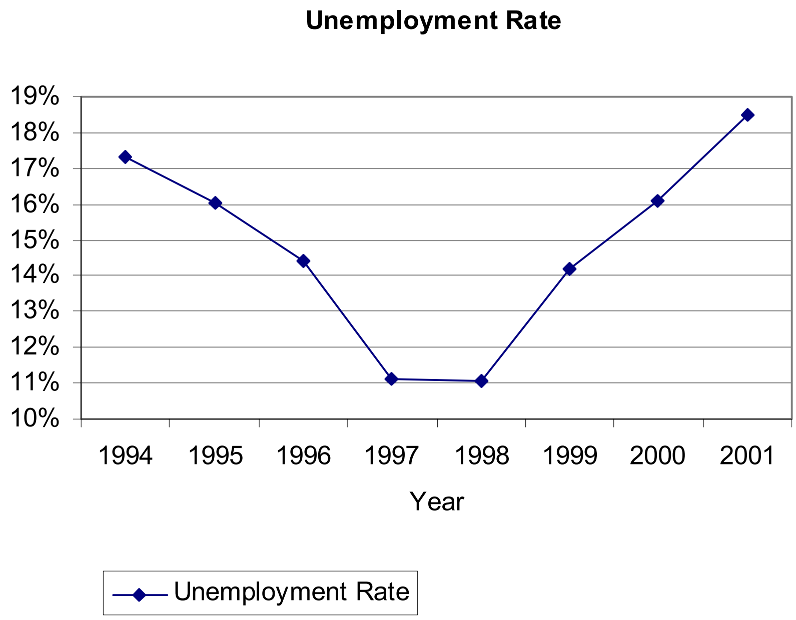
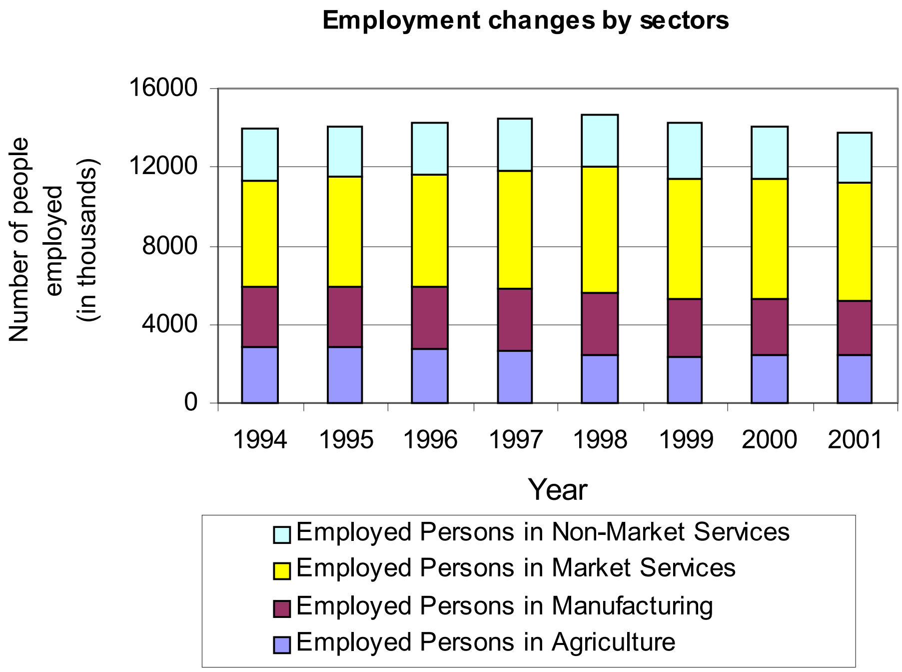


Figure 2.6.



Employment changes by sector are presented in the Figure 2.7. The increase in employment from 1994 till 1998 was determined by creating new job places in market services, manufacturing and the non-market services. In agriculture we observe a slight fall in employment from 1994 to 1996, followed by a more significant fall from 1997 to 1999. From 1998 there has been an employment decline in manufacturing and market services. From 2000 we observe falling employment in non-market services as well, with a slight increase in agriculture.

Figure 2.7



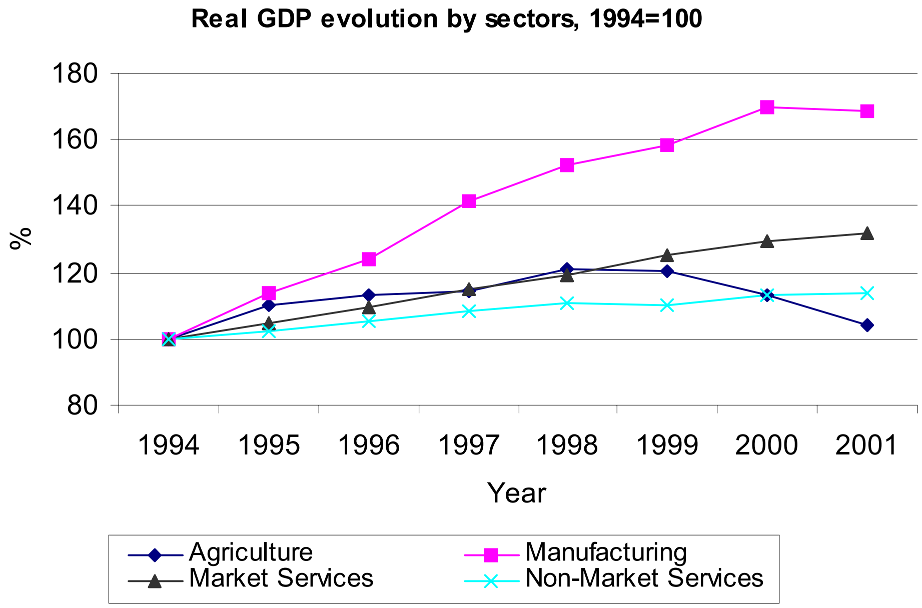
2.3 Sectoral composition of GDP

As previously shown, we observed rapid growth of GDP from 1994 until 1997 slowing down from 1998 onwards. Table 2.2 and Figure 2.8 show the evolution of GDP by sector since 1994.

Table 2.2. Real GDP growth by sectors [%], 1994=100%

	1994	1995	1996	1997	1998	1999	2000	2001
Agriculture	100.00	110.26	112.96	114.13	120.67	120.30	113.12	104.13
Manufacturing	100.00	113.70	123.72	141.52	152.11	158.55	169.88	168.55
Market Services	100.00	104.47	109.51	114.68	119.29	125.40	129.65	131.90
Non-market Services	100.00	102.57	105.24	108.26	110.68	110.27	113.28	113.55

Figure 2.8.



Following sharp growth in the manufacturing sector during the 1994-1998 period, the sector experienced slower growth in the years 1999–2000, and turning to a slight fall in 2001. Only the market services sector was growing throughout the 1994-2001 period, with particularly strong growth in construction, hotels and restaurants, transport, storage and communication, real estate, renting and business activities, wholesale and retail trade (particularly personal and household goods), and financial intermediation. A consequence of the transition is that a large middle class has emerged with the disposable income able to afford a wide range of consumer goods and services. The consumer goods market is now booming, driven by improved standards of living and the increased purchasing power of Poland's population. The market however is far from saturated, and as changes in lifestyles and living patterns continue, new demands will be created. Naturally, the growth in the consumer market has had a significant knock-on effect in other sectors of the economy. Some markets have developed from nothing (advertising, supermarket chains), others have experienced rapid growth (telecommunications, IT sector). Conversely growth in agricultural sector peaked in 1998, then from 1999 went into decline. Non-market services sector growth has stagnated around its 1994 level. It was growing from 1994 to 1998, experienced a slight fall in 1999 and turning to a growth in 2000.

2.4 Productivity

Table 2.3 shows productivity by sector for the 1994–2001 period. Table 2.4 shows strong productivity growth in manufacturing through the 1995-2001 period. Productivity growth in agriculture was significant from 1995 to 1999 but from 2000 we start to see a strong decline. The main reasons for this slow down are; increased employment and decreased GDP per employee. In contrast to the agricultural sector, the non-market services sector productivity growth was slight in 1995, 1997, and 1998 with a drop in productivity in 1996 and 1999. From 2000 the productivity growth in non-market-services sector has been remarkable.

Market services productivity growth was significant in 1999, and productivity has continued to increase.

Table 2.3. Productivity by sector in thousands PLN (GDP in sector per person employed)

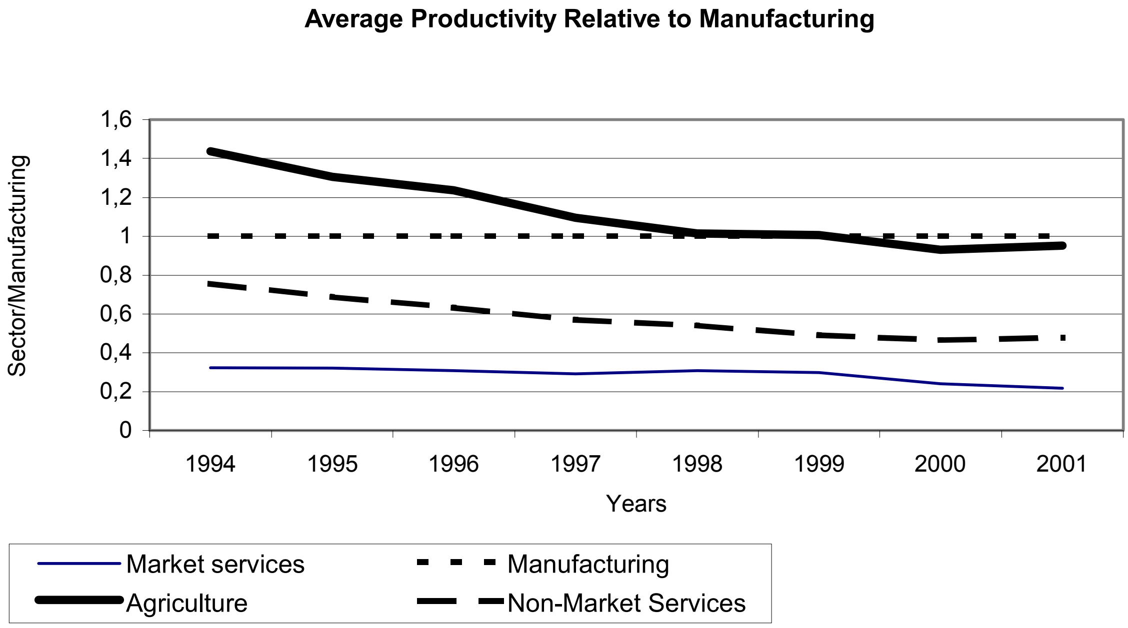
	Manufacturing	Market Services	Agriculture	Non-Market Services
1994	18.27	26.27	5.89	13.82
1995	20.49	26.74	6.59	14.10
1996	22.19	27.47	6.80	14.40
1997	25.01	27.41	7.26	14.23
1998	26.67	27.05	8.19	14.39
1999	29.19	29.38	8.72	14.28
2000	32.86	30.55	7.90	15.30
2001	33.40	31.79	7.27	15.97

Table 2.4. Productivity growth rates by sector (%)

	Manufacturing	Market Services	Agriculture	Non-Market Services
1995	12.15	1.82	11.88	2.00
1996	8.32	2.72	3.22	-0.42
1997	12.67	-0.23	6.68	1.36
1998	6.67	-1.29	12.81	1.15
1999	9.44	8.60	6.53	-0.76
2000	12.56	4.00	-9.40	7.12
2001	1.66	4.03	-8.04	4.37
Annual average	9.07	2.80	3.38	2.12

In a developed market economy productivity levels in the manufacturing (a sector that produces mainly traded goods) sector are typically higher than in martket services (a sector whose output is mainly non-traded). This is because value-added in the traded sector is less labour intensive. In the Polish economy, productivity levels in the market services sector were higher than in manufacturing up until 1999. Market services productivity levels in 1994 were 44% higher than in the manufacturing sector. Productivity levels in market services have begun to converge on manufacturing productivity levels. Over given period of time market services productivity level relative to manufacturing was decreasing. From 2000 productivity level in manufacturing has been higher than in market services. Figure 2.9 shows average productivity in different sectors relative to manufacturing.

Figure 2.9.



2.5 Wages and unit labour costs

Table 2.5 shows the growth in real consumption wages and unit labour costs in the period 1995-2000. Results shown in the Table 2.5 take into the consideration the effects of the changes made to the rules for calculation of national insurance funds. Up until the end of 1998 the employer was responsible for paying the full national insurance contribution at a rate of 45%. However, after January 1st 1999 the contribution was divided between the employee (23%), and the employer (22%). In order to maintain employees incomes wages were increased by 23%. Following continued growth in real consumption wages during the 1995-1999 period, there was a slight fall for the year 2000.

The calculation changes for national insurance rates have had an influence on unit labour costs. Manufacturing unit labour costs grew during the 1995 to 1998 period, with more significant growth in 1999, then a slight fall in the year 2000. In the services sector we saw sharp growth in unit labour costs during the 1995-1999, with slower growth in 2000. Comparison between unit labour costs in manufacturing and the service sector for the 1995 to 2000 period shows manufacturing growth at a consistently weaker level.

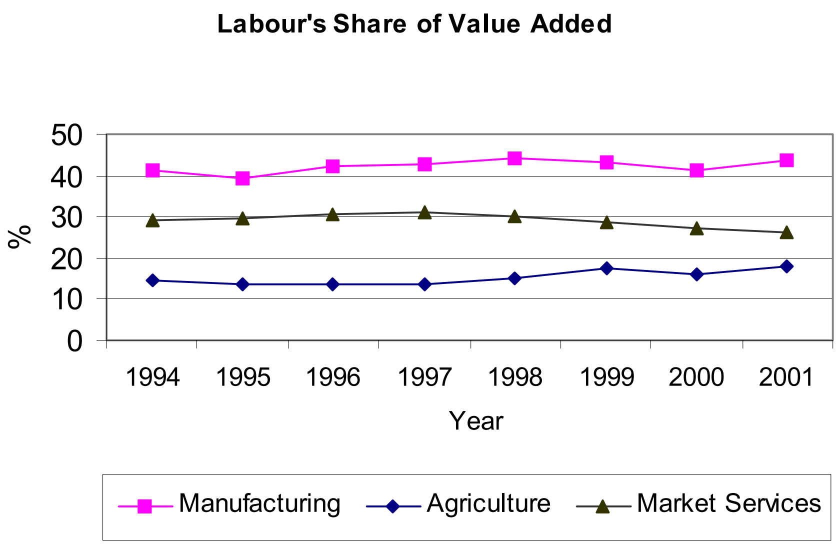
The real unit labour costs growth figures show a similar pattern to the above with the most significant growth coming in 1996. The labour share of added valves shown below in Figure 2.10 correlate with the growth rates for real unit labour cost growth in Table 2.5.

Table 2.5. Growth in real consumption wages and unit labour costs [%]

	Employee Earnings		Employer's Labour Costs			
	Real Consumption Wage Growth %		Unit Labour Costs Growth %		Real Unit Labour Costs Growth %	
	Before Tax	After Tax	Manufacturing	Services	Manufacturing	Services
1995	4.04	5.39	21.91	28.81	-4.75	1.00
1996	8.79	14.43	19.12	27.90	8.30	4.30
1997	4.90	7.47	7.68	20.13	1.11	0.65
1998	2.00	3.10	8.36	14.34	3.06	-2.00
1999	3.38	18.40	1.91	1.41	-1.86	-5.58
2000	-1.11	0,13	-2.01	3.79	-4.32	-5.43
2001[3]	1.89	4.91	5.36	2.96	-0.72	-0.9
Annual average	3.67	8.15	9.5	16.6	-0,12	-0,14

Figure 2.10 plots labours share of value added in manufacturing, services and agriculture. The graph shows that all sectors have been gradually increasing their profit share since 1994. From 1999 the effects of the changes in the way that national insurance contributions are collected have a negative impact to the otherwise upward trend.

Figure 2.10.



2.6 Investment and the capital intensity of output

The ratio of real investment to GDP in Poland rose rapidly in all sectors between 1994 and 1998. There were falls in the ratios for the manufacturing and non-market services sectors in 1999. Table 2.6 shows investment-output ratios by sector from 1994-1999. At the sectoral level, the evolution of investment-output ratios varies in individual years, but on average over the period the investment – output ratio has risen in all sectors.

[3] estimate based on preliminary data

Table 2.6. Real Investment – Output Ratios by Sector (%)

	Agriculture	Manufacturing	Market Services	Non-Market Services
1994	13.00	13.62	19.61	6.98
1995	16.76	17.03	26.68	9.67
1996	22.91	21.92	35.64	13.21
1997	31.27	26.42	46.94	17.71
1998	38.02	35.64	51.77	32.22
1999	41.92	33.34	60.67	24.58
2000[4]	48.50	33.85	63.83	26.03
2001[5]	48.19	31.10	57.27	23.70

2.7 Population, migration and participation

Poland has the largest population in Central Europe and the eighth largest in the whole of Europe. Over 98 per cent of the population are ethnic Poles. The majority of the population lives in towns and cities with over 45% of citizens living in one of the 42 larger cities (population exceeding 100 000 inhabitants). The average population density is estimated at about 24 persons per sq. km. The southern and central provinces are most densely populated with 119 to 397 persons per sq. km. It is also one of the youngest countries on the continent – half the population are under 33 years of age. In the year 2000 people under 17 years of age constituted 24 percent of the whole population and it is predicted (by the Central Statistical Office) that in the year 2005 it will still be over 20 percent. Figure 2.11 shows the age dependency rate. It is calculated as the ratio of total population to population in working age. Demographic factors have led to decrease in the age dependency rate. This drop was due to more rapid increase in working age population than in total population.

Figure 2.11.

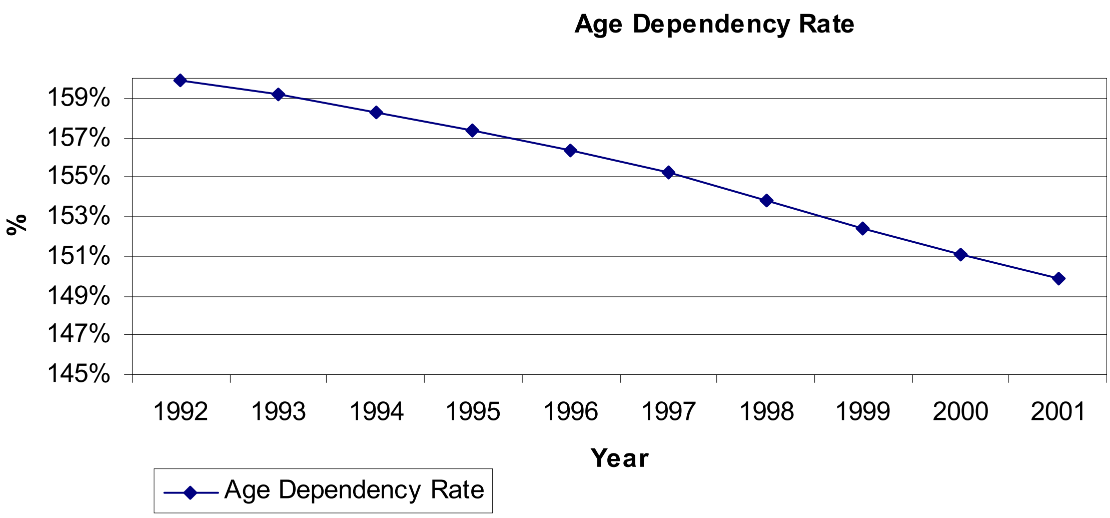


Figure 2.12 presents participation rate, which is calculated as the ratio of labour force size to population in working age. From 1992 there has been a fall in the participation rate. This fall was determined by both:

[4] Estimate based on preliminary data
[5] Estimate based on preliminary data

i. decrease in labour force size from 1992 to 1995 and a slight growth from 1996,

ii. growth in working age population throughout the 1992 – 2001.

From the year 1996, the labour force size and working age population have both experienced growth, but labour force size growth has been faster.

Figure 2.12.

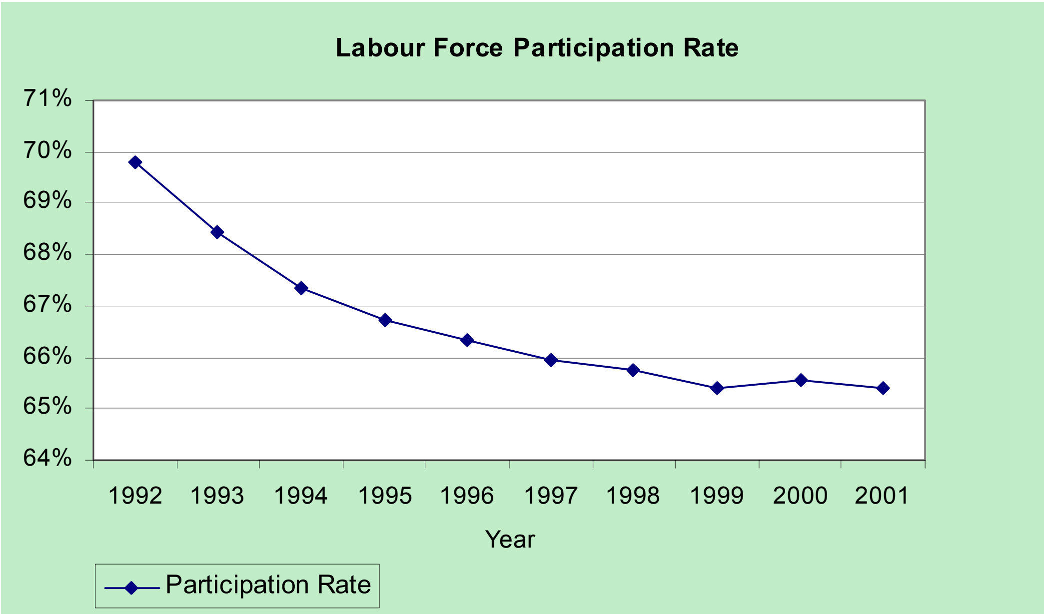


Figure 2.13.

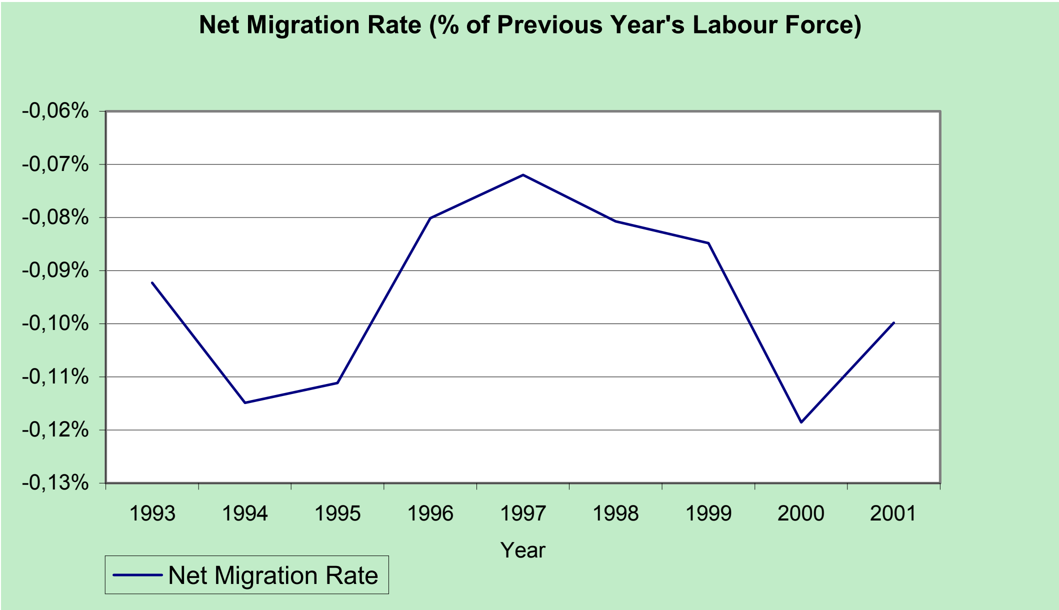


Figure 2.13 presents net migration rate. The net migration rate is calculated as the ratio of net migration to previous year's labour force. In the early transition and in 2000 there were

significant net migration flows. Between 1996 and 1999 and in 2001 net migration was lower.

2.8 Price behavior and inflation

When describing price behaviour in Poland it is necessary to consider controlled prices. The scope of controlled prices (fixed or administered) is a standard format and different institutions may use this scope in a different way. We can divide controlled prices as follows:

Strictly controlled prices: These have been set at a level established by central administration. In the period from 1994 to 2002 this category consisted of:

i. Prices of basic medicine (establish by the Minister of Finance (MF), and controlled by the Minister of Health since 2002)
ii. Prices of alcoholic beverages (established by MF and controlled by his office up until February 1998)
iii. Prices of gasoline (established by MF and controlled by his office up until February 1998)
iv. Prices of electric power (established by MF and controlled by his office up until December 1997)
v. Prices of thermal energies (established by MF and controlled by his office up until December 1997)
vi. Prices of gases (established by MF and controlled by his office up until December 1999)
vii. Fares for Polish State Railways (PKP) and Polish Motor Transport (PKS) (established by Minister of Transportation and controlled by his office up until December 1998).

Adjusted prices: These are adjusted by the rate of excise tax (established by MF). Present prices of commodities included in this category are formed on a static market, but one element of the prices is controlled - i.e. excise tax.

Prices monitored by other units: In this group the following prices are considered:

i. Uniform prices in the countries regions, these are usually establish by monopolistic enterprises e.g. passenger's railway transport, passenger's inter-city bus transport, post and telecommunication services, radio and TV payments)
ii. Price of energy carriers in accordance with the regulations of the Chairman of Office for Regulation of Energetic.

Prices that are establish by self-governing authorities in individual territories.: This category includes payments for cold water supply and sewerage, city transport and taxis.

Price behavior and inflation in the Polish economy during the early years of transition, in common with the experience of all transition economies, was explosive, and this is illustrated in table 2.7. Polish authorities managed to stabilize prices relatively quickly, and since the beginning of the transformation a downward trend has been observed in consumer price inflation.
These deflationary tendencies, (evident since August 2000) were due amongst other factors to the government's intervention on the fuel and cereal markets and to a reversal in the trends on

the international fuel market. In 2000 the GDP inflation was 7,1%; higher than in 1999 when GDP inflation was at 6.62%. In 2001 all presented annual growth rates of price deflators were lower than in 2000.

Table 2.7. Price Deflators, Annual Growth Rates (%)

	Agriculture	Manufacturing	Market Services	Non-Market Services	Personal consumption	GDP
1995	26.06	27.99	27.53	42.15	27.94	28.00
1996	13.84	9.99	22.63	24.75	19.99	18.72
1997	4.12	6.50	19.35	18.47	14.74	13.81
1998	-4.06	5.15	16.68	12.45	11.54	11.72
1999	-7.45	3.84	7.40	9.76	6.97	6.62
2000	13.08	2.42	9.75	9.32	9.89	7.10
2001	3.53	-0.51	7.28	5.06	5.12	4.84
Annual average	7.02	7.91	15.8	17.42	13.74	12.97

The stabilization of prices in recent years suggests that the price adjustment process is nearing completion.

2.9 Openness and trade

Throughout the transition period, Poland has been liberalizing its trade, mainly due to agreements with the EU. In 1999 Poland conformed with the European Agreement abolishing imports tariffs on manufactured goods, (with an exception of some sensitive sectors) from within the EU and trade liberalization is taking place in accordance with GATT and WTO agreements. Poland also grants preferential tariffs to members of CEFTA. At the end of 1998, Polish exports to its eastern markets had collapsed in the aftermath of the Russian crisis. During the course of 1999, external demand further diminished due to poor performance of the EU economy. In 2000 exports were growing faster than imports and reached levels of 31.6 bn USD, with imports at 48.9 bn USD. The acceleration in exports resulted from the following factors:

i. Slower growth in domestic consumption

ii. Improved competitiveness of Polish export offering improvements to our neighbours' business cycles.

The slower growth of imports was brought about by lower demand resulting from both weaker domestic demand and a slowdown in economic activity. Poland trades primarily with the EU. Among the EU countries, Germany is the most important trading partner, followed by Italy, France and the United Kingdom. A considerable proportion of trade was accounted for by exchanges with Russia and the United States. Until 1999 Russia was one of Poland's most important trading partners, in the course of the following year the exports to Russia considerably declined and then stabilized in 2001 at a level of 2.9%. Figure 2.14 shows the share of exports from Poland to Germany, Italy, France, the United Kingdom, the Netherlands and the Czech Republic for the years 1994-2001. The countries were Poland's main export destinations in 2001.

Figure 2.14.

Most imports come from EU countries. Among them Germany is the most important partner. Other significant imports are from Russia, Italy, France and the United States. Figure 2.15 shows the share of imports from Germany, Italy, France, the United Kingdom, Russia and the Netherlands, in Polish imports for the years 1993-2001. The countries mentioned were the largest origins of Polish imports in 2001.

Figure 2.15.

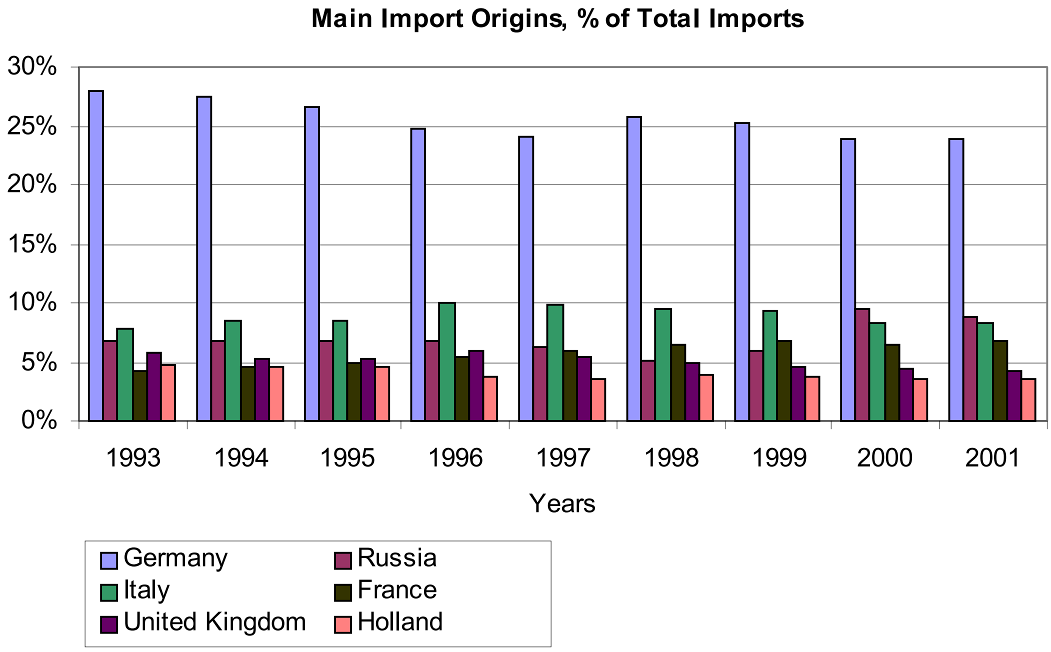


Table 2.8 shows how exports from Poland are distributed amongst the top 6 destinations for the years 1993 and 2001. The table also shows data for imports into Poland in1993 and 2001.

Table 2.8. Export share and Import share in 1993 and 2001.

	Country	1993	2001
Export Share	Germany	36.3	34.4
	France	4.2	5.4
	Italy	5.2	5.4
	The United Kingdom	4.3	5.0
	The Netherlands	5.9	4.7
	The Czech Republic	2.4	4.0
Import Share	Germany	28.0	24.0
	Russia	6.8	8.8
	Italy	7.8	8.3
	France	4.2	6.8
	The United Kingdom	5.8	4.2
	The Netherlands	4.5	3.6

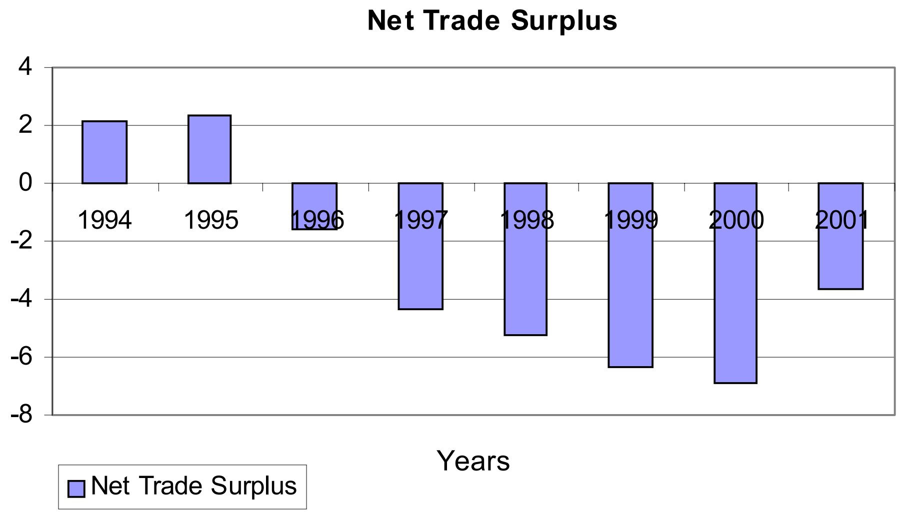
Figure 2.16 plots the share of exports and imports in GDP for the period 1994-2001. Also plotted are 'terms of trade' values (PX/PM).

Figure 2.16.

From 1994 to 1999 the gap between imports and exports was increasing and had created a growth deficit. This deficit was at its widest from 1997 to 2000, peaking at 6% of GDP in 1999. From 2000 we observed a decrease in the deficit. In 2001 the imports are only slightly higher that exports. Figure 2.16 also plots the terms of trade as a comparison of the price of exports relative to imports. These have deteriorated throughout the period with only a slight improvement during the 1997 to 1999 period.

Figure 2.17 represents net trade surplus as a percentage of GDP from 1994 to 2001. It is influenced by the following variables: GDP at market prices, private consumption, public consumption, total fixed investment, stock changes.

Figure 2.17



2.10 Public sector balance

The deficit or surplus is defined as revenue plus grants received minus expenditures and lending less repayments (for government policy purpose, and not for financial liquidity management). The deficit or surplus is also equal to total of net government borrowing plus net decrease of government cash, deposits and securities issued for financial liquidity purposes. This will give a negative quantity. The public sector deficit is defined as the difference between government expenditure and revenues.

Figure 2.18

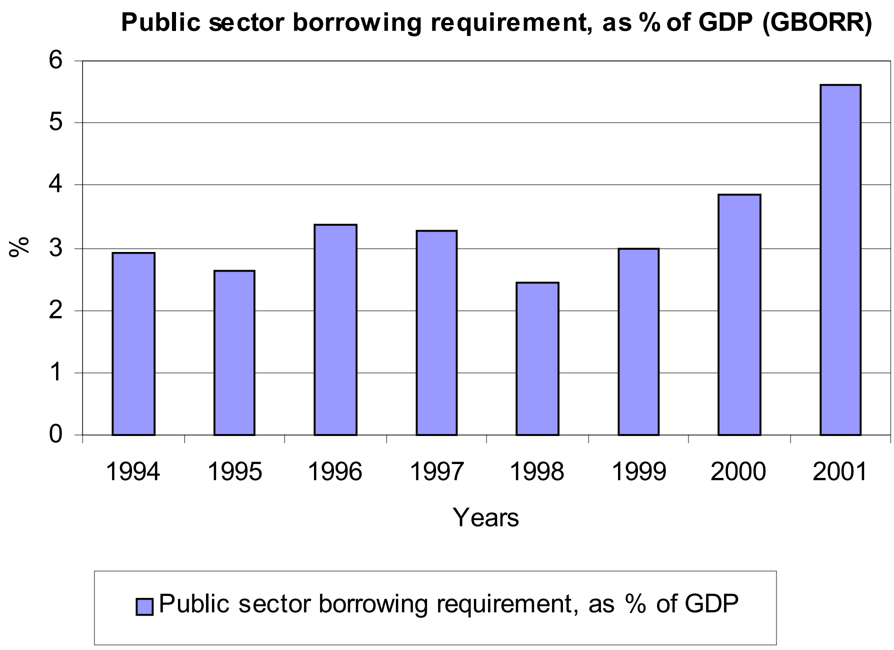
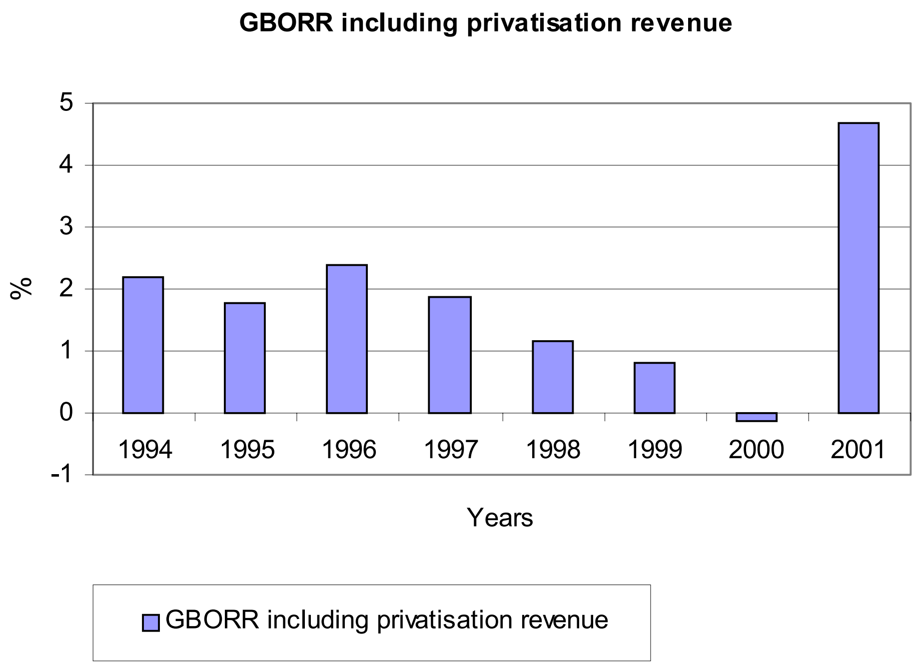


Figure 2.18 represents the public sector borrowing requirement from 1994 to 2001. It is expressed as a percentage of GDP. From 1998 to 2001 we saw a sharp growth in the public

sector deficit. From 1994, the highest public sector deficit was observed in 2001. This was caused by a faster growth of public expenditure than of tax and other revenue in the annual national budgets.

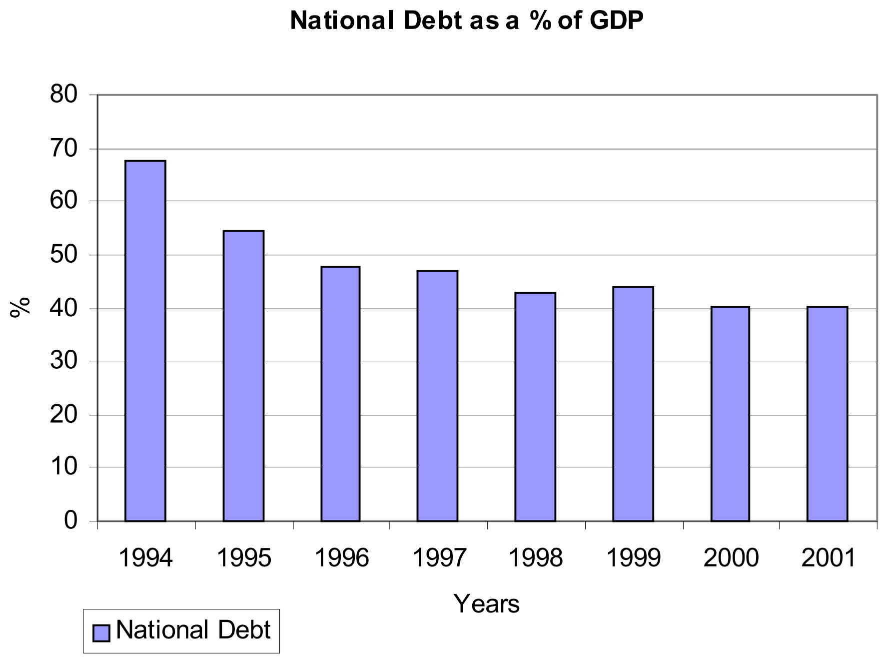
The public sector deficit, expressed as a percentage of GDP (GBORR) excludes receipts from privatisation, while the measure (GBORIMFR) includes these receipts. Privatisation revenue, (which is an element of "lending minus repayments" category) is a negative term, aggregated with expenditures for the calculation of the deficit/surplus. It had the largest effect on achieving surpluses of revenue over expenditure in the year 2000. In the year 2000, these receipts were at their highest level since 1994. But privatisation receipts collapsed in the year 2001, and the public finances on both measures moved heavily into deficit. Figure 2.19 presents GBORIMFR from 1994 to 2001.

Figure 2.19.



Polish national debt as a percentage of GDP from 1994 to 2001 is presented on the Figure 2.20.

Figure 2.20.



During the entire period, the national debt as a percentage of GDP was falling. This fall was led by GDP growth, which was faster than the growth of national debt. Table 2.9. presents growth in privatization revenue. It shows that privatization revenue grew rapidly from 1994 till 1997, then slowed down in 1998. The growth rate of privatization revenue was very high in 1999 and 2000, reaching more that 100% in 2000. We observe a significant fall in growth in 2001.

Table 2.9. Growth rate of revenue from privatization (%).

Year	1995	1996	1997	1998	1999	2000	2001
Growth rate (%)	66	42	74	8	89	104	-74

2.11 Summary of basic facts

Since the mid 1990s the Polish economy has been significantly expanding. Average living standards by the year 2000 have grown about 40 % from their 1994 levels. The rate of growth in Poland is higher than the average growth rate for EU countries. The growth in average living standards since 1994 is due to strong growth in productivity**.** The manufacturing and market services sectors have been the main engines of growth in the transformation period. In these sectors, the growth of productivity is due to both falling employment and growth in output.

The changes in national insurance rates have had a significant effect on real consumption wage growth and unit labour costs. From 1995 to 1999 we saw sharp growth in labour costs for both the manufacturing and market services sectors. At the same time significant productivity growth was seen in manufacturing, with further increase in the output prices for both sectors.

[3] The HERMIN modelling framework

3.1 Introduction

The Keynesian demand-driven view of the world that dominated macromodelling prior to the mid-1970s was exposed as being entirely inadequate when the developed economies of the OECD were exposed to 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 importance of the manner in which expectation formation was handled by modellers could no longer be ignored, and the reformulation of empirical macromodels took place against the background of a radical renewal of macroeconomic theory in general (Blanchard and Fischer, 1990).

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

An extreme example of a theoretical framework is one that treats goods as being tradeable and non-tradeable. In the one-sector small open economy model, all goods are assumed to be internationally tradeable.[6] However, recognition that domestic demand continued to play some role led to an increasing interest in the two-sector small open economy model in which some goods were assumed to be tradeable, but others were recognised to be non-(internationally)-tradeable. Although the tradeable/non-tradeable model is variously denoted the 'Australian' or the 'Scandinavian' model, its popularity is primarily due to the works of Dornbusch published in the 1970s and collected in Dornbusch (1980). Many authors, such as Helpman (1977), Lindbeck (1979), Neary (1980), Calmfors and Viotti (1982) and Cuddington and Viñals (1986a, 1986b) subsequently made important contributions to the model's development.

In this section we show how relatively simple versions of the model can be used to structure some of the debates that take place over macroeconomic issues in small open economies and regions. Our subsequent treatment of the HERMIN model shows how an empirical model can be constructed that incorporates many of these insights.

[6] It should be noted that the term "small" in "small open economy" has little to do with spatial or population size. Rather, it refers to the ability of agents in one economy to impose economic terms on agents in another. In this sense, the Polish economy is "small", the German economy is less "small", while the US and Japanese economies are "large".

3.2 One-sector and two-sector small-open-economy models

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

a) Goods produced domestically are perfect substitutes for goods produced elsewhere, so that prices (mediated through the exchange rate) cannot deviate from world levels, and

b) Firms are able to sell as much as they desire to produce at going world prices. The latter is arguably an undesirable implication, and will be further discussed later. Note that 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) $$p_t = ep_t^*$$

where e is the price of foreign currency and p_t^* is the world price. Under a fixed exchange rate this means that in this simple stylised model, domestic inflation is determined entirely abroad.[7]

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 for even as open an economy as 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 patently unrealistic. For example, it was shown that, contrary to the predictions of the model, world demand exerted an impact on Irish output *independent of its impact on price* (Honohan, 1981). To take account of this phenomenon, Bradley and Fitz Gerald (1988 and 1990) proposed a model in which all tradeable-sector production is assumed to be carried out by internationally footloose companies (MNCs) where price-setting decisions are independent of the SOE's factor costs. When world output expands, MNCs expand production at all their production locations. The proportion of MNC investment located in any individual SOE however 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.

There are two further weaknesses in the "one good" model that drive one in the direction of a generalisation to a two-sector SOE model. The first is that purchasing power parity (PPP), to the extent to which it is valid, is known to break down for substantial periods of time. PPP holds that the relationship between domestic and foreign price *levels* (rather than the prices of traded goods only) can be described by equation (3.1) above. If all goods are tradeable and if arbitrage ensures that the law of one price holds, then this relationship clearly must hold. If some goods are non-(internationally)-tradeable, however, then arbitrage does not occur. PPP

[7] For example, in the pre-1979 period when the Irish pound was linked one-for-one with sterling, Irish and UK inflation were indeed equal, and it was widely felt that breaking the link with sterling and tying to the DM would bring Irish inflation down quite rapidly to the much lower German level. However, the single sector SOE model proved to be an inadequate guide to inflation transmission.

will hold in this case only if all shocks are nominal shocks (i.e. monetary or exchange rate shocks), and even then only in the long run (if there are some nominal rigidities such as wage stickiness that apply in the short run but disappear over time).

In a model with non-tradeables, one does not expect PPP to hold in the face of real shocks, such as government expenditure or taxation changes or disequilibrating movements in wages. Labour market hysteresis would, however, invalidate PPP since nominal shocks in this scenario can exert real long-run effects (Barry (1994)).

The other weakness of the one-sector SOE model is that, as already noted, government spending is precluded from having any positive effects. Yet 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 (Walsh (1987), Barry and Bradley (1991)).

To address these criticisms, one can add an extra sector, the non-tradeable (NT) sector, to the one sector model. Output and employment in tradeables continues to be determined as before, while the NT sector operates more like a closed economy model. The interactions between the two sectors prove interesting however. The price of NTs is determined by the interaction of supply and demand for these goods. The analytical consequences of this extension of the one-sector model are described in Appendix 1.

3.3 Overview of the structure and specification of the HERMIN model

Having reviewed the theoretical background to small-open-economy modelling, we now discuss the practical and empirical implications for designing and building a small empirical model of the Polish economy. Since this new model is being constructed in order to analyse medium-term policy impacts, basically there are three requirements which the model should satisfy:

(i) The model must be disaggregated into a small number of crucial sectors which allows us at least to identify and treat the key sectoral shifts in the economy over the years of transition.

(ii) The model must specify the mechanisms through which a transition economy like Poland 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 transition economy, through trade of goods and services, inflation transmission, population emigration and inward foreign direct investment. In the case of Poland, the main external element is now the EU – in particular Germany - , and the role of the CIS has become much less significant.

(iii) The modelling framework must recognise that a possible conflict may exist between actual situation in the country, as captured in a HERMIN model calibrated with the use of historical data, and the desired situation towards which the transition economy is evolving in an economic environment dominated by EMU and the Single European Market. There is also a very important phenomenon of the changing degree of integration of the transition country into the structures of the EU which must be taken into account during the modelling process.

The HERMIN model framework focuses on key structural features of a transition economy with respect to such issues as:

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 HERMIN modelling is designed as a system composed of four sectors: manufacturing (a mainly traded sector), market services (a mainly non-traded sector), agriculture and government (or non-market) services. Given the data restrictions that we face in Poland and elsewhere, this is as close an empirical representation of the traded/non-traded disaggregation as we are likely to be able to implement in practice. The economic specification of the manufacturing and market services sectors will emulate to some degree the properties of the traded and non-traded goods sectors, respectively. Although agriculture also has important traded elements, its underlying characteristics demand special treatment, as we shall see below. 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 Polish policy makers.

The structure of the model can be best thought as being composed of three main blocks: a supply block, an absorption block and an income distribution block. Obviously, the model functions as integrated systems of equations, with interrelationships between all their sub-components. However, for expositional purposes we describe the HERMIN modelling framework in terms of the above three sub-components, which are schematically illustrated in Figures 3.1 and 3.2.

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

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-δ) Capital $Stock_{t-1}$
*Output Price = f_4(World Price * Exchange Rate, Unit Labour Costs)*
Wage Rate = f_5(Output Price, Tax Wedge, Unemployment, Productivity)
Competitiveness = National/World Output Prices

Market Service Sector (mainly non-tradable)

Output = f_6(Domestic Demand, World Demand)
Employment = f_7(Output, Relative Factor Price Ratio, t)
Investment = f_8(Output, Relative Factor Price Ratio, t)
Capital Stock = Investment + (1-δ)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 = f_9(Natural Growth, Migration)
Labour Force = f_{10}(Population, Labour Force Participation Rate)
Unemployment = Labour Force – Total Employment
Migration = f_{11}(Relative expected wage)

Demand (absorption) aspects

Consumption = f_{12}(Personal Disposable Income)
Domestic Demand = Private and Public Consumption + Investment + Stock changes
Net Trade Surplus = Total Output - Domestic Demand

Income distribution aspects

Expenditure prices = f_{13}(Output prices, Import prices, Indirect tax rates))
Income = Total Output
Personal Disposable Income = Income + Transfers - Direct Taxes
Current Account = Net Trade Surplus + Net Factor Income From Abroad
*Public Sector Borrowing = Public Expenditure - Tax Rate * Tax Base*
Public Sector Debt = (1 + Interest Rate) $Debt_{t-1}$ + Public Sector Borrowing

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

Figure 3.1: The Polish HERMIN Model Schema

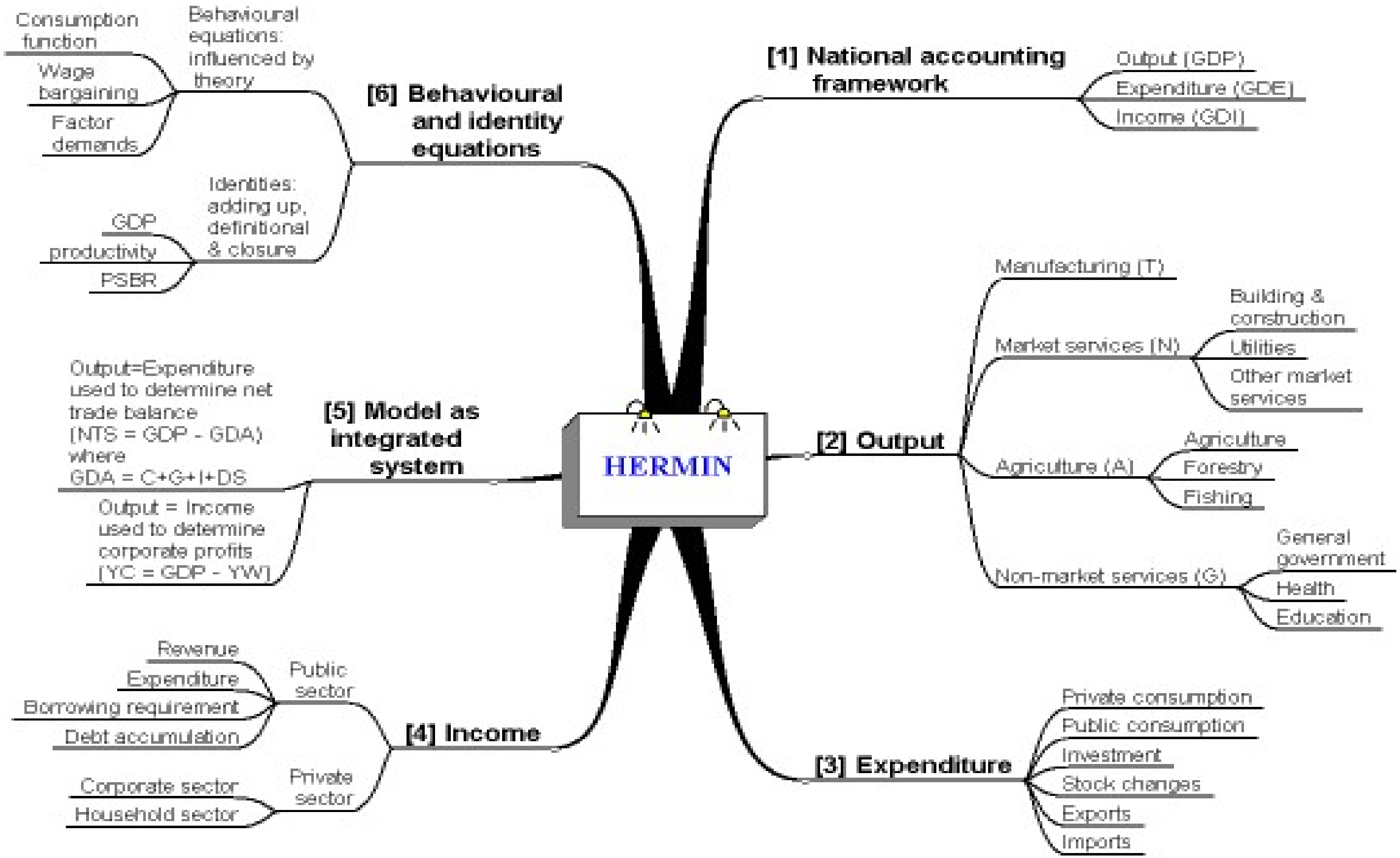


Figure 3.2: Schematic outline of Polish HERMIN modelling approach

From Figure 3.2 we see that the model handles the fact that national accounts use three complementary ways of measuring GDP: the output basis, the expenditure basis and the income basis. On the output basis, HERMIN disaggregates four sectors: manufacturing (OT), 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), and the net trade balance (NTS).[8] National income is determined on the output side, and disaggregated into private and public sector elements.

Since all elements of output are modelled, the output-expenditure identity is used to determine the net trade surplus/deficit residually. The output-income identity is used to determine corporate profits residually. Finally, the equations in the model can be classified as behavioural or identity. In the case of the former, economic theory and calibration to the data are used to define the relationships. In the case of identities, these follow from the logic of the national accounts, but have important consequences for the behaviour of the model as well. For the remainder of this section, we describe the key functional forms used in the HERMIN framework. In the next section, we will show how the key parameters in the model's behavioural equations are "calibrated" using Polish data for the eight-year post-transition period 1994-2001.

3.4 The supply side of the model

(i) Output determination

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

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

[8] We saw earlier that the logic of the traded/non-traded disaggregation implies that only a net trade surplus is logically consistent. Separate equations for exports and imports could be appended to the model, but would function merely as conveniently calculated "memo" items that were not an essential part of the model's logic.

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

A fairly simple form of the market service sector output equation (ON) is specified for this preliminary version of the Polish HERMIN model, taking the form:

(3.3) $$ON = a_1 + a_2 \, FDON + a_3 \, t$$

where FDON is a measure of domestic demandand.[9]

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

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

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

(ii) Factor demands

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

Ideally, we would like to allow for a functional form with variable elasticity of substitution, because in principle the elasticity of substitution is likely to have an inverse relation with the degree of a country's openness (Bradley *et al.*, 1995d). As the recent experience of several peripheral countries, especially Ireland, suggests (Bradley *et al.*, 1995e), the issue is of great significance for the countries in transition. When a transition economy 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

[9] Logically, the world activity term OW should have no role in a purely non-traded sector. However, in certain very open economies (such as Estonia, Latvia and Greece), some service activities that are traded (e.g., transit trade, tourism, financial services, etc.).

rather move to a different location than seek to replace costly domestic labour. In terms of the neoclassical theory of firm, the isoquants get more curved as the technology moves away from a Cobb-Douglas towards a Leontief type.

Since the Cobb-Douglas production function is too restrictive, we use the CES form of the added value production function and impose it on both manufacturing (T) 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 and market service sectors, factor demands are derived on the basis of cost minimisation subject to given output, yielding a joint factor demand equation system of the schematic form:

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

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

where w and r are the cost of labour and capital, respectively.

The above simple scheme, using a putty-putty model of the capital stock (i.e., malleable *ex ante and ex post*), proved difficult to estimate in practice. This is not surprising in light of the artificial derived nature of the capital stock data. Hence, a switch was made to a marginal, or putty-clay, system where investment, the new vintage of capital stock, is driven by output and relative factor prices, and the capital stock is assumed to be malleable *ex ante* but not *ex post*. In the absence of data on vintage output and labour inputs, the corresponding marginal output and employment are crudely proxied by the total levels of these variables. Alternatively, we can focus on the long-term formulation of the equation, when the ratio of capital to output is proportional to the ratio of investment to output.

(3.8) $$\frac{I}{Q} = (\delta + g)\frac{K}{Q}$$

where g is the growth in output and δ is the depreciation rate. Hence, the modified joint factor demand system can be written in the form:

(3.9a) $$I = h_1\left(Q, \frac{r}{w}\right)$$

(3.9b) $$L = h_2\left(Q, \frac{r}{w}\right)$$

where the capital stock is now generated by a perpetual inventory formula, (3.10) $$K_t = I_t + (1-\delta)K_{t-1}.$$

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 use of a putty-putty model (as is normally assumed when a capital stock variable is used) was believed to be too restrictive. The implementation of a full vintage model (as in the original HERMES model) was impossible, even for the four EU cohesion countries: Greece, Ireland, Portugal and Spain. The hybrid putty-clay model adopted in HERMIN is an approximation that uses investment to represent the new vintage of capital stock, but uses aggregate employment to represent labour inputs.

Although the central factor demand systems in the manufacturing (T) 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 (OW) and domestic demand (FDOT), and is influenced by international price competitiveness (PCOMPT) and real unit labour costs (RULCT). In the non-traded sector, on the other hand, output (ON) is driven purely by final demand (FDON), with possibly a limited role for world demand (OW). This captures the essential difference between the neoclassical-like tradable sector and the sheltered Keynesian non-traded sector.

(b) Second, the output price in the manufacturing (T) sector is partially externally determined by the world price. In the market services (N) sector, the producer price is a pure mark-up on costs. This puts another difference between the partially price taking tradable sector and the price making non-tradable sector.

The modelling of factor demands in the agriculture sector is treated very simply in this initial version of the Polish model. We saw above that GDP in agriculture is modelled as an inverted productivity relationship. Labour inputs into agriculture are modelled as a (declining) time trend, and not as part of a neo-classical optimizing system, as in manufacturing and market services. The capital stock in agriculture is modelled as a trended capital/output ratio. We recognise that there are complex challenges facing Polish agriculture, as it restructures under the pressure of EU accession. Ideally, the HERMIN model needs a satellite model where the institutional aspects of agriculture are fully included. In later versions of the HERMIN model it will be possible to expand the simple approach.

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

(iii) Sectoral wage determination

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

(3.11a) $$\text{WNDOT} = \text{WTDOT} + \text{error}$$

(3.11b) $$WADOT = WTDOT + error$$

(3.11c) $$WGDOT = WTDOT + error$$

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

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

a) *Output prices*: The price that the producer can obtain for output clearly influences the price at which factor inputs, particularly labour, can be purchased profitably.

b) *The tax wedge*: This wedge is driven by total taxation between the wage denominated in output prices and the take home consumption wage actually enjoyed by workers. The wedge effect arises because workers try to bargain in terms of a take home wage denominated in consumer prices and not in terms of gross pre-tax wages denominated in producer prices.

c) *The rate of unemployment*: The unemployment or Phillips curve effect basically states that the more people who are unemployed in an economy, the lower will be the subsequent wage demands from those still with job and who seek jobs. In this formulation, unemployment is 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. they want at least to enjoy some of the gains from higher output per worker.

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

(3.12) $$Log(WT) = a_1 + a_2 \log(POT) + a_3 \log(WEDGE) + a_4 \log(LPRT) + a_5 UR$$

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

Demographics and labour supply

It is possible to endogenise population growth through a "natural" growth rate, corrected for net additions or subtractions due to migration. Net migration flows can be modelled using a standard Harris-Todaro approach that drives migration by the relative attractiveness of the Polish and international labour markets, where the latter can be proxied by the German market (Harris and Todaro, 1970). Attractiveness is usually measured in terms of the relative expected wage, i.e., the product of the probability of being employed by the average wage in each region. Finally, the labour force participation rate (i.e., LFPR, or the fraction of the working-age population (NWORK) that participates in the labour force (LF)), can be modelled as a function of the unemployment rate (UR) and a time trend that is designed to capture slowly changing socio-economic and demographic conditions.

(3.13) $$LFPR = a_1 + a_2 \, UR + a_3 \, t$$

3.5 Absorption in HERMIN

Private consumption

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

(3.14) $$CONS = a_1 + a_2 \, YRPERD$$

Consequently, households are assumed to be liquidity constrained, in the sense of having very limited access to savings or credit in order to smooth their consumption. In later extensions of the Polish HERMIN model, a more sophisticated approach will be explored and adopted. For example, in the Irish HERMIN model, experiments were carried out with hybrid liquidity constrained and permanent income models of consumption. However, it was found that the long-run properties of the model were relatively invariant to the choice between a hybrid and a pure liquidity constrained function. However, if a forward looking model of wage income is used, the properties of the model change radically (Bradley and Whelan, 1997).

As for the remaining elements of absorption, public consumption is determined primarily by public employment, which is a policy instrument. Private investment is determined within three of the four sectors as elements of the sectoral factor demand systems. Public investment is a policy instrument. Due to the absense of data on inventory changes, this element of absorption is ignored. Finally, and in keeping with the guiding spirit of the two-sector small-open-economy model described earlier, in HERMIN we do not model manufactured exports and imports explicitly. Instead, the net trade surplus is residually determined from the balance between GDP on an output basis (GDPFC) and domestic absorption (GDA, i.e., private and public consumption, private and public investment and stock changes). Hence, to the extent that a policy shock drives up domestic absorption more than output, the net trade surplus falls (or equivalently the trade deficit rises).

3.6 National income in HERMIN

(i) The public sector

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

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

$$(3.15)\quad \Delta RGTY = \alpha\left\{\frac{(GNDT - GNDT^{*})}{GNPV}\right\} - \beta\left\{\frac{(GNDT - GNDT^{*}) - (GNDT_{-1} - GNDT^{*}_{-1})}{GNPV}\right\}$$

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

(ii) The national income identities

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:

(3.16) YC = GDPFCV - YW

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

(3.17) YP = GDPFCV + GTR

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

(3.18) 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

(3.19) YPERD = YPER - GTY

where GTY represents total taxes paid by the household sector. It is the constant price version of YPERD (i.e., YRPERD=YPERD/PCONS) which drives private consumption in the simple Keynesian consumption function:

(3.20) $$CONS = a_1 + a_2 \ YRPERD$$

(iii) The monetary sector

There is no monetary sector in this first complete version of the HERMIN model for Poland. Consequently, both the exchange rate and domestic interest rates are treated as exogenous. The nominal "anchor" in the model is the world price, denominated in foreign currency. Furthermore, the financing of any public sector borrowing is handled in a rudimentary fashion, with any net flow of annual public sector borrowing being simply accumulated into a stock of debt.

[4] Calibrating the HERMIN behavioural equations

4.1 Introduction

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

As in the standard HERMIN models (Bradley *et al*., 1995b), the HERMIN model for Poland contains 261 equations, many of which are merely included to increase the model's transparency and facilitate simulation and policy analysis exercises.[10] The essential core of the model consists of a smaller number of equations, of which less than twenty are behavioural in a strictly economic sense (i.e., empirical versions derived from an underlying theoretical specifications, containing parameters that must be assigned numerical values). These are the equations we will focus on in the following paragraphs.

Before proceeding with the analysis of the individual equations, a few qualifying remarks concerning our approach to calibration are appropriate. As will be apparent from the descriptive material presented in Section 2, the data constraints enable us to work only with about eight annual data observations for the period 1994-2001 at best, since the data prior to 1994 are incomplete and not very reliable. The small number of observations available prevented us from undertaking the sophisticated econometric estimation and hypothesis testing techniques commonly used to calibrate macro models.

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

(i) Extending the data sample over different economic regimes

For the Polish W8-2000 model, data for the period 1960-1998 are used (Welfe, Welfe, Florczak and Sabanty, 2002). The advantage is that this provides 39 annual observations and facilitates econometric hypothesis testing and estimation. The disadvantage is that the extended data sample covers three very different economic regimes: the era of Polish Communist economic planning; the years immediately following the collapse of the Communist economic system; and the era of rapid recovery and growth that followed the post-Communist collapse, which coincides with the 1994-2001 data sample that we used in the discussion of section 2..

(ii) The Panel data approach

This is the approach used within the CEE models contained in the NIGEM model of the world economy developed by the London-based NIESR (Barrell and Holland, 2002). A series of CEE economic data bases are assembled for the post Communist era, a generalised

[10] For example, the wage in manufacturing (WT) is determined in a behavioural equation. But the inflation rate (WTDOT) is determined in an identity, merely to facilitate the examination of simulation output.

model is posited that is appropriate to each of the constituent economies, and cross-economy constraints are imposed. For example, a common marginal propensity to consume might be imposed on all models. This has the advantage of increasing the degrees of freedom and obtaining more precise parameter estimates. A possible disadvantage is that the cross-economy restrictions are difficult to test.

(iii) Simple curve-fitting to post 1994 data

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

The curve-fitting approach to calibrating the Polish HERMIN model relies on judgement, aided by single equation estimation using "ordinary least squares" (OLS). We look to the OLS output to give us some usable curve-fitting information on the values of model parameters that appear to make the behavioural equation roughly congruent with the data. However, we sometimes modify these calibrated parameters in the light of the underlying theoretical implications for the range of values as well as the empirical experience from others modelling exercises in the EU cohesion countries (such as Greece, Ireland and Portugal). Sometimes we impose a particular parameter value for which we have some prior (extra-model) knowledge in order to be able to estimate the remainder of the parameters. On almost all occasions we have therefore run several regressions with modified structure, from which we picked up the one fitting best the underlying assumptions. In a few equations, we are simply unable to calibrate the parameters using OLS, and in those cases we impose values that are plausible in the light of the known characteristics of the Polish economy. This is not a very satisfactory situation, but is somewhat better than the technique used in computable general equilibrium (CGE) models of calibration using a single observation.

There are fifteen main behavioural equations that have to be calibrated in the Polish HERMIN model, as follows:

- GDP arising in manufacturing (OT)
- The factor demand system in manufacturing (employment (LT) and investment (IT)
- The GDP deflator for manufacturing (POT)
- Average annual earnings in manufacturing (WT)

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

- 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)

- Household consumption (CONS)

- Expenditure prices (investment (PI) and consumption (PCONS))

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. We avoid the use of any dummy variables. In particular, structures such as the CES production function are imposed to make calibration easier. There is an obvious loss in modelling sophistication and in capturing dynamics of adjustment and behaviour, but there is little or nothing that one can do about these problems. The following sections provide discussion of the calibration process for each behavioural equation and technical details on the chosen specification.

4.2 The supply side of HERMIN - manufacturing

(i) Manufacturing output

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

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

Two main scale variables are the measure of the world output (OW) and final domestic absorption (FDOT). The variable OW is derived as a weighted average of the industrial production indices of the main trading partners of Poland, where the weights are constructed from export shares for eighteen of Poland's trading partners (see Table 5.1).

The variable FDOT, on the other hand, is constructed from input-output (I/O) weights and the main components of domestic absorption.[11] The real unit labour cost

RULCT = ULCT/POT

[11] The weights in the construction of FDOT capture the manufacturing output content of domestic absorption: consumption (CONS), government non-wage consumption (RGENW), and investment expenditure, decomposed into building and construction (IBC) and machinery and equipment (IME). The decomposition of total investment into IBC and IME ponents is needed to analyse the impacts of an NDP-related shock to public investment, where this is likely to be mainly construction activity.

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

$$PCOMPT = POT/PWORLD$$

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

Table 5.1 : Polish exports shares by destination
(percentage of 18 export destinations)

Trading partner	1994	2001
Germany	43.25	42.07
France	4.82	6.62
Italy	6.02	6.59
United Kingdom	5.51	6.09
The Netherlands	7.14	5.78
Czech Republic	3.21	4.85
Belgium	2.95	3.77
Russia	6.56	3.59
Sweden	3.12	3.34
Denmark	3.87	3.16
United States	4.16	2.88
Hungary	1.29	2.56
Austria	2.66	2.48
Spain	1.25	1.97
Norway	0.80	1.38
Finland	2.12	1.01
Switzerland	1.07	0.96
Portugal	0.19	0.88

As shown in the previous section, we specified an output equation as follows:

$$Log(OT) = a_1 + a_2 \log(OW) + a_3 \log(RULCT) + a_4 \log(FDOT) + a_5 \log(PCOMPT) + a_6 t$$

This is probably the most important equation in the model, yet we failed completely to calibrate it using simple OLS techniques. We used the export share data (i.e., the share of exports in GDP) to impose the coefficient on OW (the world "driver"), and calibrated the coefficient of FDOT (the domestic "driver") as one minus the coefficient of OW. The calibration search exercises suggested negative values of the relative prive (PCOMPT) elasticity and the real unit labour cost (RULCT) elasticity, as theory would suggest. But it is well known that these types of aggregated equations often have very low price elasticities, and larger elasticities only emerge when manufacturing is disaggregated into it's component sub-sectors (Carlin, Glynn and Van Reenen, 2001).

The calibrated values of the other behavioural parameters were specified as follows:

a_2	a_3	a_4	a_5	a_6
0.24 (imposed)	-0.30 (imposed)	0.76 (imposed)	-0.30 (imposed)	0.026

Table 5.2: Parameters in manufacturing output equation (OT)

Hence, a 1 percent rise in Polish real unit labour costs (RULCT) or in Polish relative prices (PCOMPT) will produce a 0.30 per cent decline in OT. A 1 per cent rise in world output (OW) will produce a 0.24 per cent rise in OT, while a 1 per cent rise in weighted domestic demand (FDOT) will produce a 0.74 per cent rise. Even with a relatively crude parameter calibration, the within sample tracking performance of the equation is quite good, and is illustrated below in Figure 5.1:

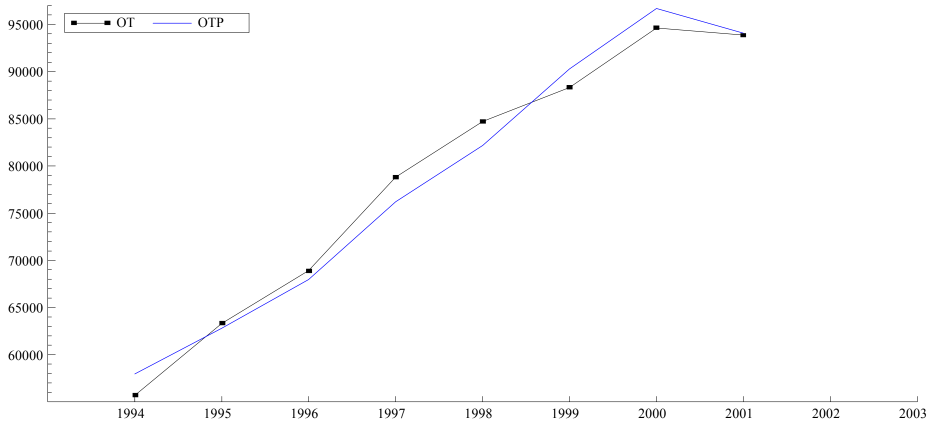


Figure 5.1: Manufacturing output: actual (OT) vs predicted (OTP)

(ii) Factor demands in manufacturing

We described in section 3 how the CES production function was a useful form to use in modelling, being less restrictive than the Cobb-Douglas and yet remains relatively easy to handle: [12]

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

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

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

[12] Remember that the data constraints prevent us from using more sophisticated production functions, such as generalised Leontief, that might be more appropriate if we were to focus on the short-run transitional dynamics.

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

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

The first step of the calibration (Berndt, 1991) required estimation of the factor proportions (LT/IT) equation and yields two of the four production function parameters. Since unconstrained estimation yielded implausible results - an elasticity of substitution greater than unity- we imposed a value between Cobb-Douglas and Leontief production functions by setting the elasticity of substitution to 0.80. The results of the second stage of the calibration procedure for Polish manufacturing are summarised in the following table:

Parameter	A	σ	δ	λ
Value	11.31	0.8 (imposed)	0.912	0.0816

Table 5.3: CES production function parameters: manufacturing

Among the parameters, the technological rate of change has the largest impact on the dynamic behaviour of the model, because it imposes an exogenous steady state growth of this sector. Once its counterpart from the market services (or N) sector demand equations is recovered (see below), the two will interact in shaping the growth of the economy. At about 8.2 per cent, the rate of technical progress in Polish manufacturing appears to be very high, and must be reduced in out-of-sample simulations. We merely present it’s within-sample calibrated value for the record.

In Figure 5.2 (a) and (b) we show the (single equation) plots of the actual factor demands versus the values predicted by the calibrated equations:

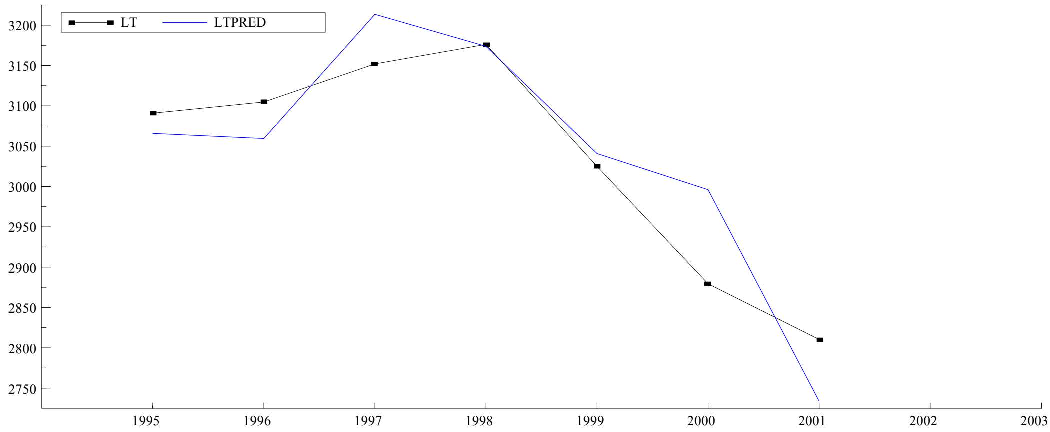


Figure 5.2(a): Employment in manufacturing: actual (LT) vs. predicted (LTP)

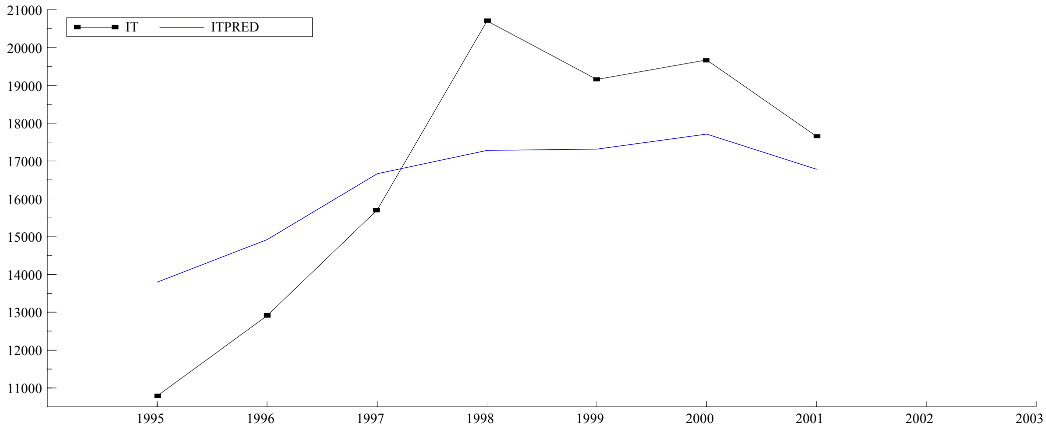


Figure 5.2(b): Investment in manufacturing: actual (IT) vs. predicted (ITP)

The graphs in Figure 5.2 were produced by taking the factor demand equations (for LT and IT) and inserting the calibrated parameters. The fits are not very good, but capture the general trend. It must be remembered that the factor demand system has been theoretically imposed and has none of the ad-hoc additions and adjustments usual in such equations in empirical models. The under-performance of the investment equation between 1998 and 2000 suggests that expectational and confidence factors may have boosted investment above what the conventional model predicted. With the onset of recession in the year 2001, the actual and predicted values move closer together.

(iii) Manufacturing output price

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

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

where PWORLD stands for a weighted measure of price indices external to Poland. At present, this is taken as a trade-weighted average of the prices in Poland's main trading partners. Calibration of the above relationship yielded a coefficient of 0.57 on PWORLD (and consequently, 0.43 on ULCT). The coefficient on PWORLD is somewhat larger than the degree of openness of the Polish economy might suggest, but this is a common phenomenon..[13]

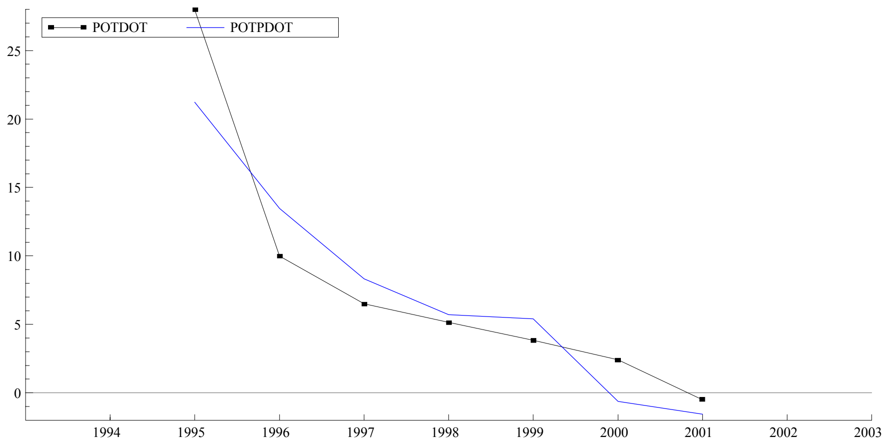


Figure 5.3: Manufacturing price inflation: actual (POTDOT) vs. predicted (POTPDOT)

(iv) Average annual earnings in manufacturing

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

The conventional theory of bargaining spells out four dominant factors of wage determination. The first is the price index of the sector output, POT. This, according to the neo-classical theory of firm, determines the maximum level of nominal wage that the employers are willing to pay for the existing level of employment to be profitable. The second is the sectoral labour productivity, LPRT, which increases the room for nominal wage rises consistent with preserving constant factor shares. Next, the tax wedge, WEDGE, comprising the effects of direct and indirect taxation including the social contributions, has an important role, because workers are concerned not with gross wages but with the net

[13] In the year 2001, the Polish export/GDP ratio was 29.8 per cent, while the import/GDP ratio was 33.5 per cent.

purchasing power of their wages. Finally, high unemployment reduces the bargaining power of labour unions, thereby alleviating their pressure for nominal wage rises. An obvious generalisation of the above discussion leads to the equation of the form:

$$Log(WT) = a_1 + a_2 \log(POT) + a_3 \log(WEDGE) + a_4 \log(LPRT) + a_5 \, URBAR$$

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

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

$$Log(WT) = a_1 + a_2 \log(PCONS) + a_3 \log(LPRT) + a_4 \, URBAR + a_5 \log(WEDGE)$$

where wages are now linked directly to consumption prices (PCONS), to a measure of productivity in manufacturing (LPRT), and to the unemployment rate. We imposed full price indexation. But we were unable to recover plausable coefficients on the tax wedge or on unemployment. The calibration yielded the following results, as a subset of the more general equation:

a_2	a_3	a_4	a_5
1.0 (imposed)	0.496	0.0	0.0

Table 5.4: Parameters in manufacturing wage equation (WT)

Hence, in this equation wages are assumed to be fully indexed to consumption prices. About one half of all productivity growth in manufacturing is passed on to wage earners, with the result that the share of added-value going to labour (i.e., LSHRT=YWT/OTV) is likely to decline over time. The absence of a negative Philips curve term in disturbing, since it excludes an important feedback mechanism from the model. However, we are not aware of any studies of the Polish labour market that have identified this effect. The tracking performance is reasonably good and the general pattern of wage inflation is captured.

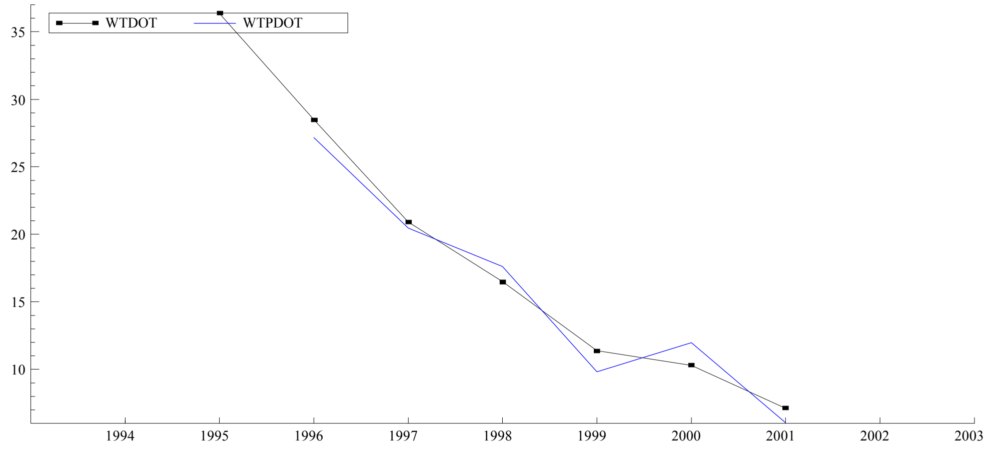


Figure 5.4: Wage inflation in manufacturing: actual (WTDOT) vs predicted (WTPDOT)

(v) Trend productivity

The model also contains an equation that calibrates the trend evolution of productivity, obtained by regressing the log of productivity (LPRT) against time. The calibrated trend growth rate of productivity is 9.0 per cent, and the fit is shown in Figure 5.5 below.

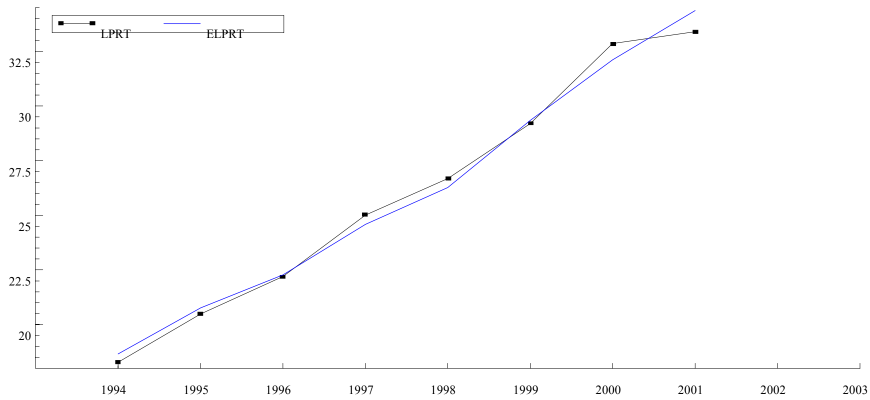


Figure 5.5: Actual productivity (LPRT) vs. trend productivity (ELPRT)

4.3 The supply side of HERMIN – market services

(i) Market services output

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

$$ON = a_1 + a_2 \text{ FDON} + a_3 t$$

where ON denotes GDP arising in the market services sector, FDON is a weighted average of the various components of the domestic absorption, with the weights determined by N-sector output content from the I-O tables, and OW represents world activity. The calibration results are provided in the following table:

Parameter	a_2	a_3
Value	0.694	0.0

Table 5.5: Parameters in market services output equation (ON)

This means that a rise of one unit in FDON is associated with a rise of 0.7 units in N-sector GDP. The within-sample predictive power of the equation is illustrated below.

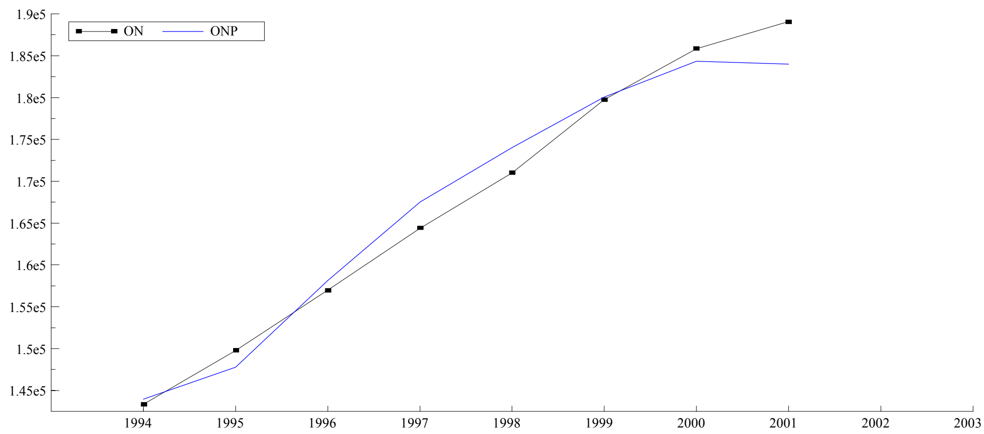


Figure 5.6: GDP arising in market services: actual (ON) vs. predicted (ONP)

(ii) Factor demands in market services

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

$$ON = A \exp(\lambda t)\left[\delta \{LN\}^{-\rho} + (1-\delta)\{IN\}^{-\rho}\right]^{-\frac{1}{\rho}},$$

where ON, LLN, and IN refer the familiar categories of output, labour and investment, this time in the market servives sector. Similarly, the parameter λ denotes an exogenously given rate of technological progress, assumed to be Hicks-neutral.

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

$$\log(IN/LN) = \log\left(\frac{1-\delta}{\delta}\right)^{\sigma} + \sigma \log(ERFPN),$$

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

Parameter	A	σ	δ	λ
Value	14.22	0.5 (imposed)	0.535	0.018

Table 5.6: CES production function parameters: market services

The implied rate of technical progress - at 1.8 per cent per year - is considerably lower than in the more capital intensive manufacturing sector, where it was 8.2 per cent.[14]

In Figure 5.7 (a) and (b) we show the (single equation) plots of the actual factor demands versus the values predicted by the calibrated equations. The graphs in Figure 5.7 were produced by taking the factor demand equations (for LLN and IN) and inserting the calibrated parameters. The fits are not good, but it must be remembered that the factor demand system has been theoretically imposed and has none of the ad-hoc additions and adjustments usual in such equations in empirical models.

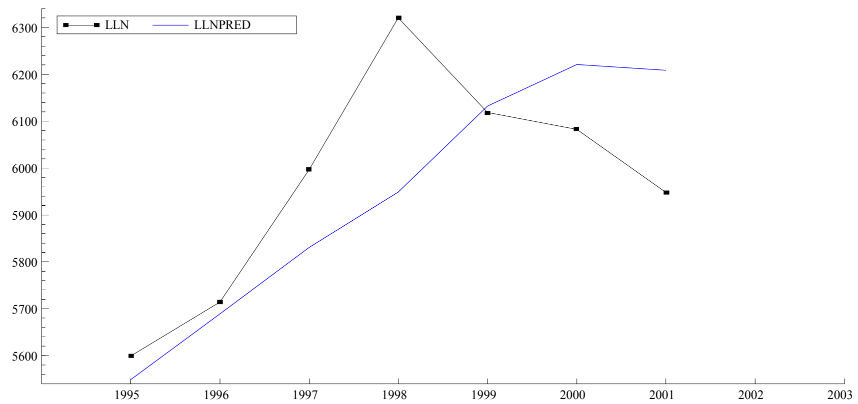


Figure 5.7(a): Employment in market services: actual (LLN) vs. predicted (LLNP)

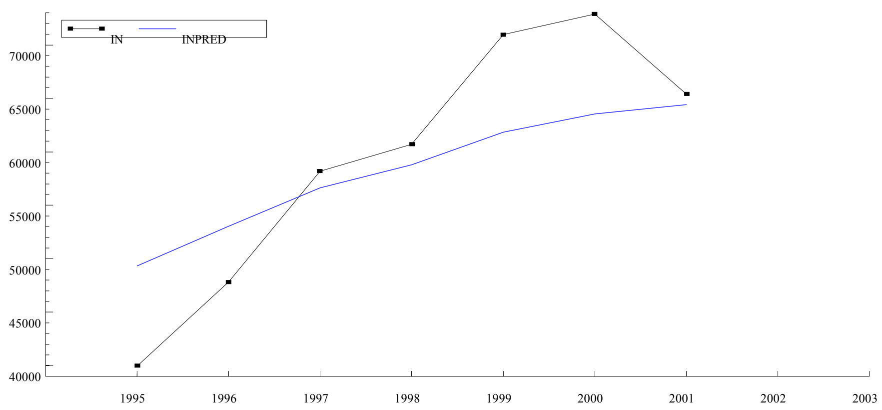


Figure 5.7(b): Investment in market services: actual (IN) vs. predicted (INP)

[14] Later we will show how these high with-sample rates of technical progress can be modified in out-of-sample projections.

(iii) Market services output price

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

$$\log(PON) = a_1 + a_2 \log(ULCN) + (1 - a_2)\log(ULCN_{-1})$$

where PON refers to the price index of the market services sector and ULCN is the sector unit labour cost. The calibration yielded the value of the a_2 coefficient of about 0.60. Hence, 60 per cent of changes in unit labour costs are reflected in prices within the same year, and the remaining 40 per cent with a lag of one year. The tracking performance (for inflation rates) is shown in Figure 5.8:

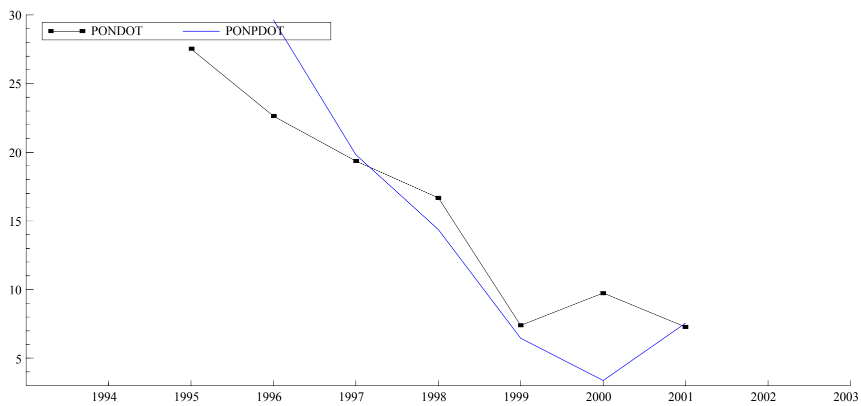


Figure 5.8: Price inflation in market services: actual (PONDOT) vs. predicted (PONPDOT)

(iv) Average annual earnings in market services

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

WNDOT = WTDOT + error

WADOT = WTDOT + error

WGDOT = WTDOT + error

where WTDOT, WNDOT, WADOT and WGDOT are the inflation rates of WT, WN, WA and WG respectively. The accuracy of this assumption is illustrated in Figure 5.9 below.

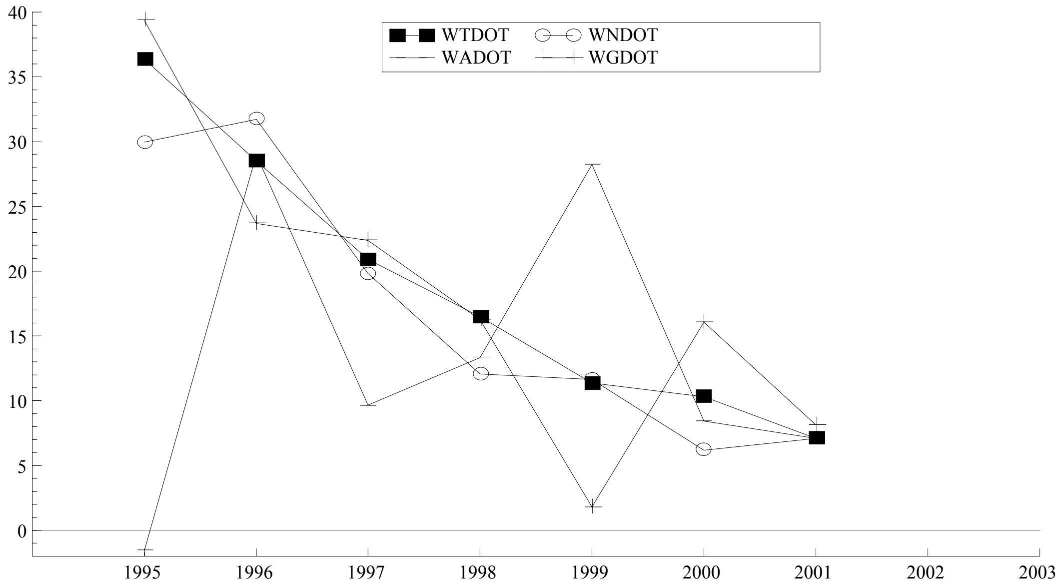


Figure 5.9: Wage inflation in the four HERMIN sectors – T, N, A and G

Hence, the assumption made is seen to be relatively accurate in the case of market services (WNDOT), less accurate, but still broadly valid, in the case of the public sector (WGDOT), and not at all appropriate in the case of agriculture (WADOT).[15] However, we retain the assumption in all sectors pending more detailed investigation of wage determination in the Polish labour market.

4.4 The Agriculture sector

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

(i) Agricultural output:

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

$$\log(OA/LA) = 1.67 + 0.034\, t$$

Hence, productivity in agriculture has grown at a trend rate of 3.4 per cent per year over the period 1994-2001.

[15] Clearly, the path of WGDOT shown in Figure 5.9 is very "lumpy", as periodic adjustments are made to the wage rates in non-marketed services in order to bring them into line with wage rises in the private (market) sectors. However, we are more interested in the medium-term trends in WGDOT rather than the year-on-year changes. The Scandinavian model assumptions provide a useful stylised out-of-sample projection mechanism.

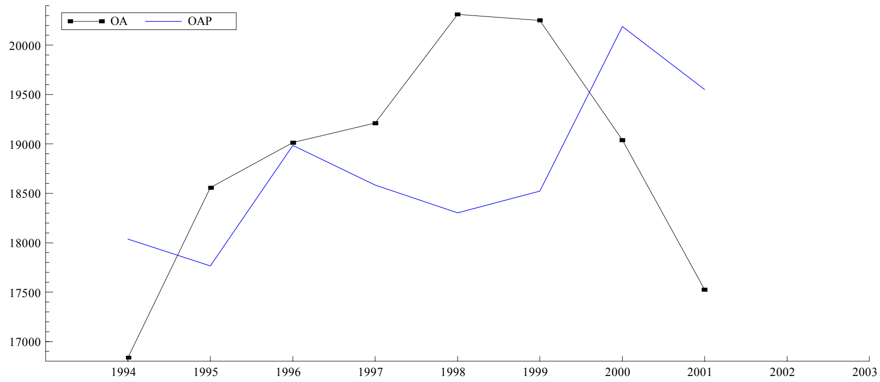


Figure 5.10: GDP arising in agriculture: actual (OA) vs predicted (OAP)

(ii) Employment in agriculture:

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

$$\log(LA) = 8.11 - 0.029\, t$$

Hence, employment in agriculture has declined at a trend rate of 2.9 per cent per year over the period 1994-2001.

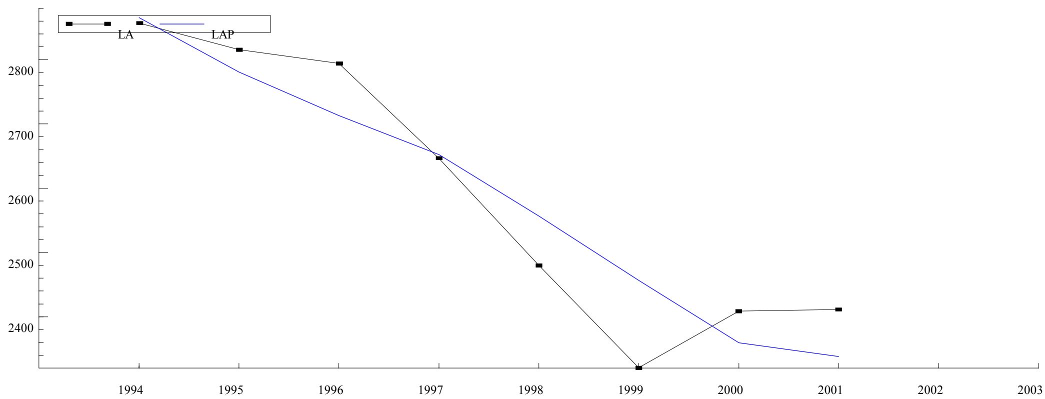


Figure 5.11: Employment in agriculture: actual (LA) vs predicted (LAP)

(iii) Fixed capital stock in agriculture:

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

$$\log(KA/OA) = -0.072 + 0.093\, t$$

Hence, the capital intensity of agricultural output appears to have increased at a rate of 9.3 per cent per year over the period 1994-2001.

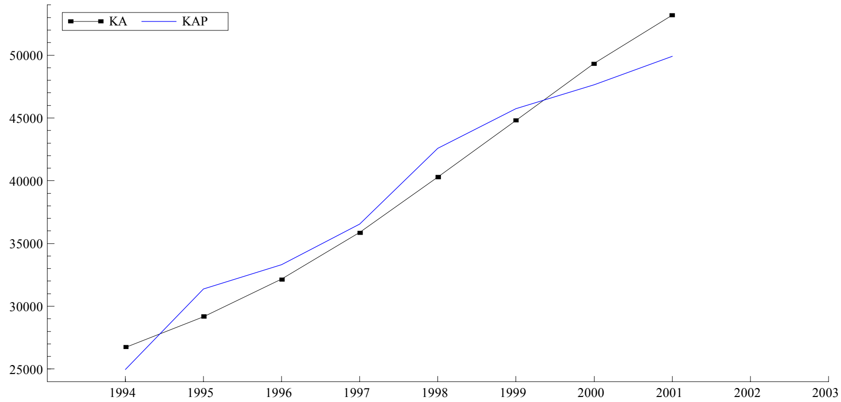


Figure 5.12: Capital stock in agriculture: actual (KA) vs. predicted (KAP)

In summary, the results reveal that while agriculture output and employment have declined during the 1990s, the sector has become more capital intensive.

4.5 The non-market services sector

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

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

This equation merely adopts the assumption of the Scandinavian model discussed above, and model wage inflation as being driven by wage inflation in manufacturing (see Figure 5.9 above).

(ii) Output price in non-market services

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

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

with POG denoting the public sector output deflator and WG is the wage rate. This is shown in Figure 5.13:

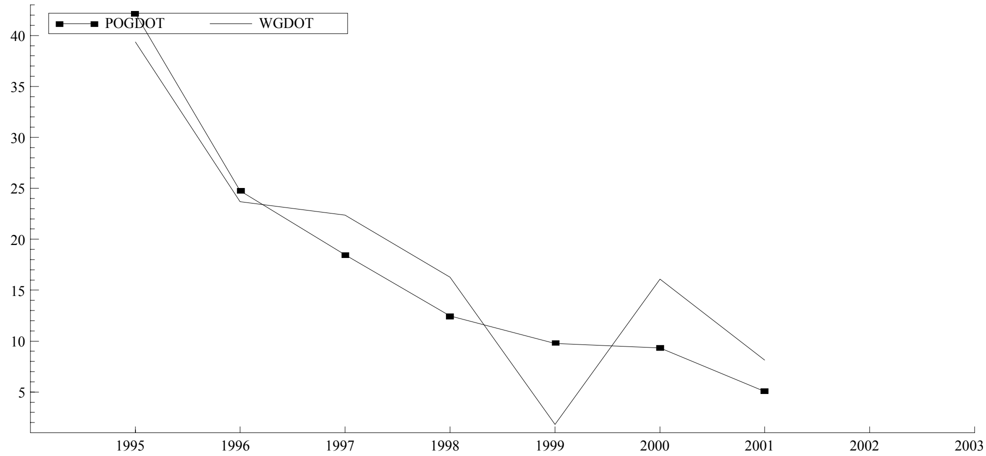


Figure 5.13: Public sector – wage (WGDOT) and price (POGDOT) inflation

4.6 Demographics and supply of labour

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

(i) Labour force participation rate

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

$$LFPR = 68.3 - 0.27\ t$$

The tracking performance of the equation is shown below.

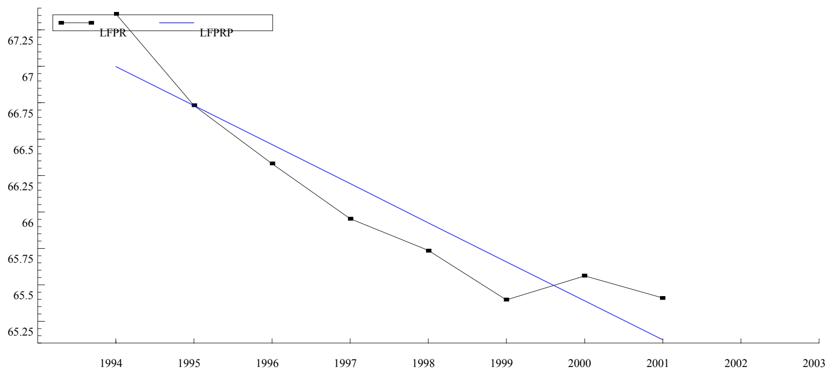


Figure 5.14: Labour force participation rate: actual (LFPR) vs. Predicted (LFPRP)

4.7 The absorption side of HERMIN

(i) Private Consumption:

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

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

$$CONS = a_1 + a_2 \, YRPERD$$

where the crucial parameter is the marginal propensity to consume (MPC), measured by the size of the parameter a_2. The calibration suggested an impact MPC of 0.44, and a long-run MPC of 0.66. This is somewhat lower than we expected, but this result is broadly within the expected range. The plot of actual vs. predicted indicates that the fit is quite good (Figure 5.15).

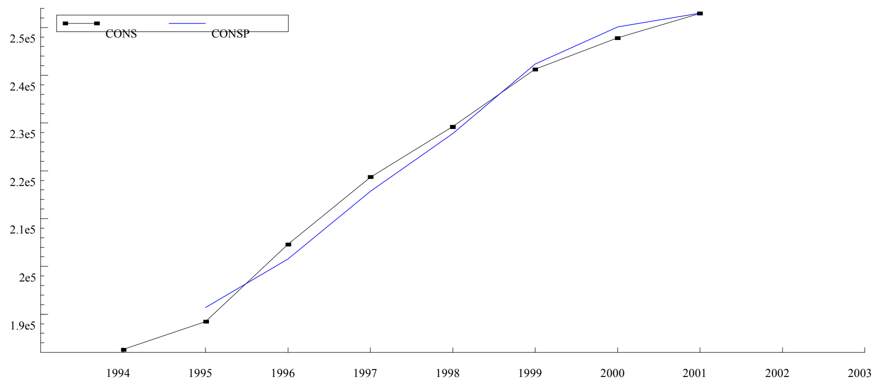


Figure 5.15: Household consumption: actual (CONS) vs predicted (CONSP)

The OLS approach must, of course, recognise that the data from the early part of the 1990s (i.e., 1990-1993) are characteristic of the first phase of transition, and the later observations are more likely to have been generated by underlying structures from the second (or "cohesion-like") phase of transition. It is the structure of the economy in this second phase that is of interest. This problem of structural change obviously exacerbates an already bad data situation and tends to throw more emphasis on the need to over-ride the OLS parameters and insert crucial parameter values taken from EU cohesion country estimation (e.g., Greece, Ireland, Portugal).

4.8 Expenditure prices

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

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

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

There are two such equations in the Polish model. The first explains the behaviour of the deflator of total investment (PI), and is used to subsequently explain the behaviour of the sectoral investment deflators (PIT, PIN, PIA and PIG). The second explains the behaviour of the consumption deflator (PCONS). The calibration results were as follows:

	PGDPFC	PM	TINC
Equation for PI	0.424	(1-0.424)	0.0
Equation for PCONS	0.5 (imposed)	(1-0.5)	1.0 (imposed)

Table 5.7: Parameters for expenditure price equations (PI and PCONS)

What this implies is that the investment expenditure deflator is partially anchored to movements in import prices (PM) and partially reflect movements in domestic output prices (PGDPFC). However, it proved impossible to calibrate the PCONS deflator with this simple model, probably because a significant fraction of Polish consumer prices are still "administered". We imposed plausible coefficients, assuming that all changes in indirect tax rates passed on fully to consumption prices.

In Figure 5.16 (a) and (b) we show how the above equations track inflation rates within sample.

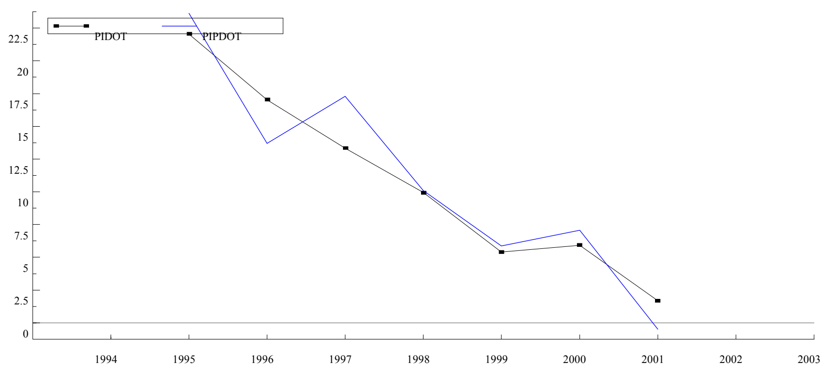


Figure 5.16(a): Investment price inflation: actual (PIDOT) vs. predicted (PIPDOT)

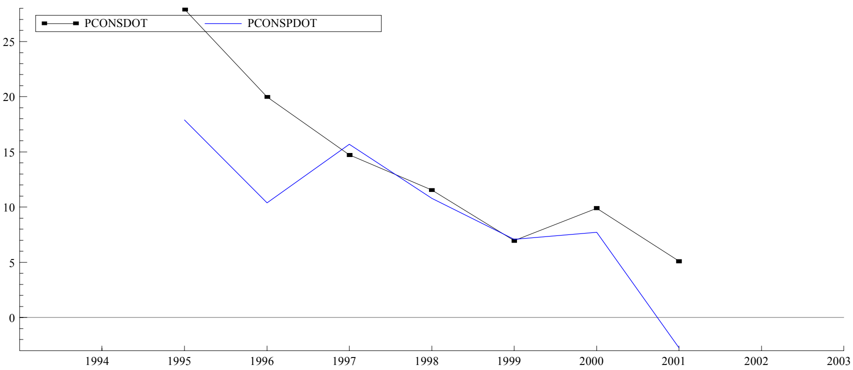


Figure 5.16(b): Consumption price inflation: actual (PCONSDOT) vs. predicted (PCONSPDOT)

4.9 Government expenditure

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

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

(i) Domestic transfer payments (GTRO)

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

$$GTRO = RGTRO * (N*PCONS)$$

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

(ii) Unemployment transfers (GTRU)

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

$$GTRU = RGTRU * U$$

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

Subsidies (GSUB and GSUBO)

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

$$GSUB = RGSUB * GDPFCV$$

$$GSUBO = RGSUBO * GDPFCV$$

This has the effect of causing subsidy payments to increase in line with nominal GDP. If it is desired to break this link (say, to run down subsidies as a share of GDP), then they can simply be treated as exogenous instruments. Most other less important items of public expenditure are treated as policy instruments. With respect to expenditure on public sector wages, the policy instrument is numbers employed (LG), and the wage rate is linked to the rate in manufacturing (see Figure 5.9 above). Hence, the public sector wage bill is endogenous.

4.10 Taxation and revenue

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

(i) Personal income taxation

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

$$GTY = RGTY * YW$$

(ii) Revenue from corporate taxation (GTYC)

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

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

(iii) Indirect taxation

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

$$GTE = RGTE * CONSV$$

(iv) Import duties (GTM)

These taxes are assumed to be levied on the value of total imports (MV) at a rate RGTM:[16]

$$GTM = RGTM * MV$$

[16] Note that HERMIN models the net trade surplus (NTSV) and does not contain separate trade equations (for imports and exports). To model import duties, the value of imports is included as an exogenous variable (MV), and is projected out-of-sample at an appropriate growth rate.

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

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

$$GREVO = RGREVO * GDPFCV$$

4.11 The public sector borrowing requirement (GBOR)

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

$$GBOR=(GEXP - GREV)$$

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

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

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

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

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

4.12 National income

(i) Undistributed corporate profits

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

$$YCU = YCURAT * YC$$

Since only the distributed element of corporate profits (YC-YCU) should properly enter into personal income, this mechanism is important within the model. However, since we were unable to obtain data for Poland, we imposed a coefficient of 0.2 for the implicit rate YCURAT, so that we assume that 80 per cent of corporate profits enter into personal income, 20 per cent being retained within the corporate sector for investment purposes.

[5] Model testing and responses to shocks

5.1 Introduction

The behavioural equations and identities described in the previous section are assembled to form the complete Polish HERMIN model. In the previous section we examined the with-sample tracking performance of the behavioural equations, treated in isolation. Now we must examine the performance of the system of equations as a whole.

We first discuss how we checked the validation and internal consistency of the model by means of within sample simulations. Then, we will briefly describe the process of forcing the model's behavioural equations to track the within-sample data exactly (i.e., "fixing" of intercept adjustments or "add-factors" for the behavioural equations of the model). We then present a simple projection scenario that attempts to construct a medium term forecast, predicated on an assumed development of the exogenous (or driving) variables of the model. Finally, we subject the model to a 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, we should not neglect its within sample performance. Not only is a reasonable within sample tracking a necessary condition for the model to be realistic, but it would also point out the weak parts of the model, i.e. the behavioural equations whose calibration neglected some important factors. Therefore checking of the model's within sample properties provided much valuable information on the quality of the calibration process and we often had to return back to the calibration stage when such a check produced unsatisfactory results.

The control of the within sample performance was carried out by a means of a so-called residual check simulation. Once the individual behavioural equations were calibrated (see the preceding section for details), and the model as a parameterised system of equations was set up, we ran a static simulation which used the historical values of the endogenous and exogenous variables on the right hand side of each equation of the model to compute the behavioural variable that is determined by this equation. The resulting set of values of the endogenous variables for every simulated year of the sample was then compared to their actual historical values. More specifically, we were interested in the percentage difference of the simulated from actual values.

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

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

5.3 Projections: external and policy assumptions

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

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

External (or world) variables

There are about 20 variables in this important category.

(a) <u>World economic growth</u>: The rate of growth in Poland's main trading partners (i.e., the 18 export destinations that include Germany, France, Italy, the United Kingdom, etc.) is assumed to be 5 per cent per year from 2002-2010.

(b) <u>External prices</u>: There are eleven such prices: the price of imports (PM), agricultural prices (POA), as well as the output prices of manufactured goods in a series of Poland's main trading partners.[17] A common inflation rate of 3 per cent per year is assumed for the period 2000-2010.

(c) German unemployment rate: This is available for use should one wish to endogenise migration flows. But in the preliminary version of the Polish model, migration flows are left exogenous.

Internal (or policy) variables

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

(a) Public employment (LG): Employment numbers are frozen at their 2001 value.

(b) Other elements of real public consumption (RGENW, OGNW): These are frozen at their 2001 values.

(c) Other elements of public expenditure (e.g., IGV): These are projected to grow in nominal terms at the same rate as world prices (i.e., 3 per cent per year). Thus, they are assumed to be maintained approximately fixed in real terms, *ex ante*.

(d) Tax rates: These are fixed at their 2001 values. Consequently, revenues (in nominal prices) will grow at the same rate as the relevant tax base (e.g., CONSV in the case of RGTE, the rate of indirect taxes).

(e) The exchange rates of the Polish zloty against the currency of Poland's main trading partners: These are projected as being fixed at their 2001 values.

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 2001 values (see above).

(b) Miscellaneous: Most remaining exogenous variables are projected as being fixed in real terms, *ex ante*.

Modifications of time trends

A range of time trends have been used in the model, and values were calibrated using the within-sample data from 1994-2001. However, it would be foolish to project these trend rates of growth unchanged into the medium term. The following are the main assumptions made:

(a) Hicks neutral technical progress: The calibrated values within-sample were 8.2 per cent and 1.8 per cent for manufacturing and market services, respectively. Out of sample, the rate

[17] In HERMIN models of EU countries, the exogeneity of agricultural prices follows from the Common Agriculture Policy (or CAP). For Poland, the exogeneity assumption was made for lack of any plausible alternative mechanism.

for manufacturing was halved, and the rate for market services was set to zero. Hence, the assumption is made that while technical progress will continue, it will do so at considerably less than the rate that characterised the transition period 1994-2001.

(b) Agricultural productivity growth: The within-sample growth rate of 3.4 per cent per year was projected unchanged.

(c) Agricultural employment: The within-sample decline of 2.9 per cent per year was reduced by 50 per cent, and a trend rate of decline of under 1.5 per cent per year was imposed.

(d) The capital/output ratio in agriculture: The within sample growth rate of 9.3 per cent was projected unchanged.

(e) Labour force participation rate: The within-sample annual decline was about one quarter of a percentage point per year. This was set to zero out of sample, and consequently the participation rate was frozen at its 2001 value of 65.4 per cent of the labour force.

Behavioural intercept adjustments

For the calculation of these, see above. We make the simple assumption that the value of the 2001 within-sample error for the behavioural equations is projected forward to 2010 unchanged. However, where a behavioural equation defines a rate of change or a flow (wage inflation in the N-sector (WNDOT), etc.), then we project the error as zero.

5.4 A stylised projection for 2001-2010

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

Table 5.1 shows the world slow-down in the year 2001 (the last year for which we have within-sample data), and the impact on the Polish growth rate. After 2001 the "world" growth rate is projected at 5 per cent, and we see that Poland under-performs relative to this growth rate. If such a scenario were actually to come to pass, Polish GDP per capita would diverge from the EU average, rather than converge. Turning to the sectoral growth rates, the manufacturing sector growth slightly out-performs the world, but growth in the sheltered marketed services sector underperforms by more than 50 per cent. The agricultural growth rate was effectively set exogenously, as was the growth in non-marketed services (set to zero).

Projections for the levels on employment and unemployment are shown in Table 5.2. These suggest that total employment increases by some 1.35 million over the nine-year period 2001-2010, made up of increases of 370,000 and 1,214,000 in manufacturing and market services, respectively. Employment declines in agriculture by 233,000 and there is no change in employment numbers in the non-market services sector. These last two results arise directly as a consequence of prior assumptions imposed on the model in section 5.3. Since the labour force is static (a result of exogenising the working-age population, and freezing the labour force participation ratio), unemployment numbers fall by 1.35 million, and the unemployment rate declines from 18.7 per cent in the year 2001 to 11.1 per cent in 2010.

Table 5.1: Sectoral output growth rates

Date	OW	GDPFC	OT	ON	OA	OG
2001	0.54	0.30	-0.78	1.73	-7.95	0.24
2002	5.00	-0.01	-0.59	0.13	1.46	0.00
2003	5.00	3.10	6.12	2.33	2.01	0.00
2004	5.00	2.69	5.31	1.94	2.01	0.00
2005	5.00	2.76	5.34	1.99	2.01	0.00
2006	5.00	2.82	5.37	2.04	2.01	0.00
2007	5.00	2.87	5.39	2.07	2.01	0.00
2008	5.00	2.92	5.40	2.10	2.01	0.00
2009	5.00	2.97	5.41	2.12	2.01	0.00
2010	5.00	3.02	5.43	2.15	2.01	0.00

OW: "world" output; GDPFC: real GDP at factor cost; OT: GDP in manufacturing
ON: GDP in market services; OA: GDP in agriculture; OG: GDP in non-marketed services

Table 5.2: Employment and unemployment levels

Date	L	LT	LLN	LA	LG	LF	U	UR
2001	13710	2810	5948	2411	2540	16862	3152	18.69
2002	13960	2906	6067	2447	2540	16931	2972	17.55
2003	14123	2959	6213	2411	2540	16931	2808	16.58
2004	14237	2988	6333	2376	2540	16931	2694	15.91
2005	14358	3017	6459	2342	2540	16931	2573	15.20
2006	14487	3048	6590	2308	2540	16931	2444	14.44
2007	14621	3080	6726	2275	2540	16931	2310	13.64
2008	14762	3113	6867	2242	2540	16931	2170	12.81
2009	14908	3146	7012	2210	2540	16931	2023	11.95
2010	15061	3180	7162	2178	2540	16931	1871	11.05

L = total employment; LT = manufacturing; LLN = market services; LA = agriculture
LG = non-market services; LF = total labour force; U = numbers unemployed; UR = unemployment rate

In Table 5.3 we show the public and private sector imbalences, all expressed as percentages of GDP. The first measure of the borrowing requirement (GBORR) excludes receipts from privatisation, while the second measure (GBORIMFR) includes these revenues. In the year 2000, these receipts were at their highest level since 1994, and pushed the public finances into a small surplus, at least according to the second – or IMF – measure, GBORIMFR. But privatisation receipts collapsed in 2001, and the public finances on both measures moved heavily into deficit (almost twice the Maastricht criterion of 3 per cent of GDP). By the year 2006, the national debt has risen by 10 percentage points, and declines to its year 2001 level by 2010, under the influence of a falling public sector borrowing requirement. Over the ten years, the net trade position moves from a serious deficit of almost 4 per cent of GDO in 2001 to a surplus of 1 per cent of GDP in 2010.

Finally, in Table 5.4 we illustrate the consequences for the inflation rate. The strengthening of the zloty in 2001 shows up as a negative "world" inflation rate (denominated in zloty). After 2001 the zloty is assumed to be fixed relative to all other currencies, and the "world" inflation rate (denominated in "world" currencies) is set at 3 per cent. The simulation shows that the inflation rate of manufacturing output prices are more than twice as high as that of market services, due to the fact that the manufacturing price is partially anchored to the (fixed) "world" price, and the fact that productivity growth in manufacturing greatly exceeds that of market services. The aggregate inflation rate for all output is slightly higher than the "world" rate, as is the consumption inflation rate. The consequences for wage inflation are also clear, but it should be recalled that only half of the productivity increase is passed on to wages. The net effect is a gradual decline in real unit labour costs, which serves to boost manufacturing output.

Table 5.3: Public and private sector imbalances

Date	GBORR	GBORIMFR	RDEBT	NTSVR
2000	3.85	-0.13	40.19	-6.91
2001	5.63	4.67	40.37	-3.66
2002	6.70	5.77	45.01	-3.48
2003	6.60	5.73	47.90	-3.57
2004	5.98	5.17	49.73	-3.04
2005	5.09	4.35	50.53	-2.43
2006	4.07	3.37	50.27	-1.79
2007	2.96	2.31	48.96	-1.13
2008	1.79	1.19	46.62	-0.45
2009	0.57	0.01	43.27	0.25
2010	-0.69	-1.20	38.94	0.96

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

Table 5.4: The inflation environment

Date	PWORLD	POT	PON	PGDPFC	PCONS	WT	LPRT	ULCT	RULCT
2001	-7.28	-0.51	7.28	5.64	5.12	7.11	1.66	5.36	5.90
2002	3.00	3.86	2.87	2.84	2.92	0.93	-3.86	4.98	1.08
2003	3.00	2.24	4.47	3.78	3.39	5.54	4.23	1.25	-0.96
2004	3.00	2.44	5.89	4.80	3.90	6.09	4.30	1.72	-0.71
2005	3.00	2.47	6.12	4.94	3.96	6.16	4.30	1.78	-0.67
2006	3.00	2.47	6.15	4.93	3.96	6.15	4.30	1.78	-0.67
2007	3.00	2.46	6.14	4.90	3.94	6.14	4.30	1.76	-0.68
2008	3.00	2.45	6.12	4.86	3.93	6.12	4.30	1.74	-0.69
2009	3.00	2.44	6.10	4.82	3.91	6.10	4.30	1.72	-0.70
2010	3.00	2.44	6.08	4.78	3.89	6.07	4.30	1.70	-0.71

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

The above projections are very experimental in nature and should not be taken too seriously. When they are compared with the "official" medium-term forecasts, we may be able to learn something about the mechanisms of the model and perhaps we may also be able to learn something about the logical assumptions underlying the "official" forecasts.

5.5 Shocking the model

We now examine the properties of the Polish HERMIN model using a series of simulated shocks to exogenous variables. In order to examine the full medium-run properties of the model, we need to simulate the model over a long period. To do this, we use the projection made in the previous section as a baseline for the period 2001 to 2010.[18] After shocking one or more variables from a given year (2002) onwards, a new projection is produced. This new projection can be compared with the original baseline solution. Our interest is to understand the system-wide properties of the model when it is subjected to such exogenous shocks. The change relative to the baseline projection shows us the consequences of the shock over time. Out of the wide range of possible multipliers we present here four cases that are particularly important. These are:

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

(i) A shock to world output (OW)

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

Table 5.5 and Figure 5.1 shows the effect of this shock on total GDP, as well as on manufacturing sector output (OT) and market services sector output (ON). Total output as well as output in both sectors respond to the boost in world output. Activity in manufacturing rises by just under 3 per cent, while the rise in market services output is about ten times smaller. These reactions simply reflect the structure and parameters in the model. The elasticity of OT with respect to OW in the equation for manufacturing output is 0.24, so on a single equation basis, a 10 per cent rise in OW will produce a 2.4 per cent rise in OT.[19] The model simulation produces a slightly larger impact, due to the indirect effect of increased manufacturing activity on market services output (ON). There is no impact on agricultural output, and public sector output is exogenous. This low impact may seem rather pessimistic, but the very partial nature of the OW shock needs to be appreciated. In actual fact, increased "world" activity would lead to increased inward direct investment (FDI) for Poland, but this mechanish has not yet been incorporated into the basic Polish HERMIN model.

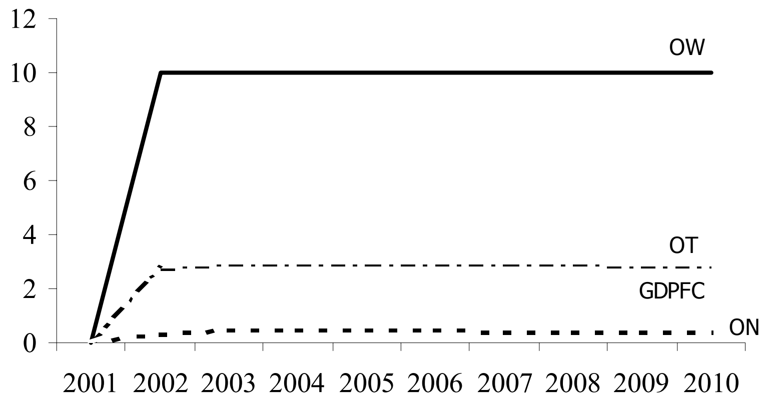
[18] We actually simulate out to the year 2020 in order to check the very long-run stability of the model.
[19] For very open economies like Ireland and Estonia, the elasticity of manufacturing output with respect to "world" output is much higher.

Table 5.5: Effects of 10% rise in level of "world" output
(percentage change relative to baseline)

Date	OW	OT	ON	GDPFC
2001	0.00	0.00	0.00	0.00
2002	10.00	2.74	0.30	0.92
2003	10.00	2.89	0.42	1.05
2004	10.00	2.90	0.43	1.08
2005	10.00	2.89	0.42	1.10
2006	10.00	2.88	0.41	1.11
2007	10.00	2.87	0.40	1.12
2008	10.00	2.86	0.39	1.13
2009	10.00	2.84	0.38	1.14
2010	10.00	2.83	0.37	1.15

OW: "world" output; GDPFC: real GDP at factor cost;
OT: GDP in manufacturing; ON: GDP in market services

Figure 5.1: Effects of 10% rise in level of "world" output (OW)
(percentage change relative to baseline)



(ii) A public employment shock (LG)

Table 5.6 and Figure 5.2 presents the model's response to a sustained 10 percent increase in the number of employees in the public sector (LG). In levels, this amounts to an increase of about 254,000 new jobs in the sector. The increase in expenditure on public sector wages is financed by running a larger deficit (if necessary) and not by increasing tax rates or cutting public expenditure elsewhere.

As can be seen from Table 5.6, total employment increases initially by 289,000 as a result of the Keynesian demand mechanism when the extra public sector employees spend their wages. This steadily increases to about 328,000 at the end of the simulation period. indicating a relatively weak Keynesian employment multiplier of about 1.29. We emphasise again that this simulation was run under the assumption that tax rates are exogenous and there is no fiscal crowding-out effect.

Table 5.6: Effects of 10% increase in public sector employment

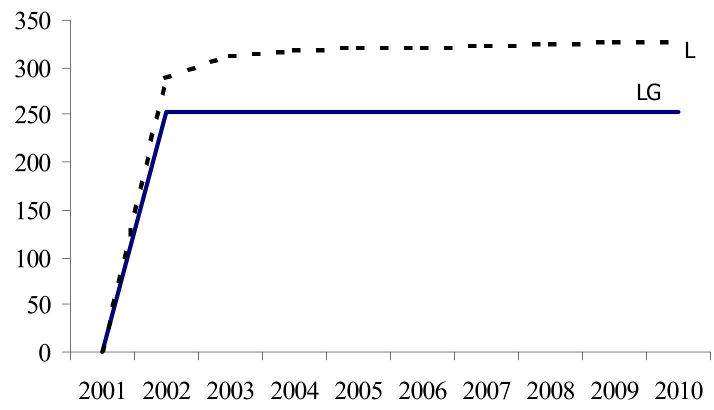
(Change relative to baseline, thousands)

Date	LG	L	Multiplier
2001	0.00	0.00	0.0
2002	254	289	1.14
2003	254	312	1.23
2004	254	317	1.25
2005	254	320	1.26
2006	254	321	1.26
2007	254	323	1.27
2008	254	324	1.28
2009	254	326	1.28
2010	254	328	1.29

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

Figure 5.2: Effects of 10% increase in public sector employment (LG)

(Change relative to baseline, thousands)



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

(iii) A shock to government investment (IGV)

The next shock we examine relates to an increase in public investment in infrastructure. Table 5.7 and Figure 5.3 show the effect of a permanent 10 percent increase in nominal public investment. As can be seen from Table 5.7, there is a initially small positive Keynesian multiplier effect of 1.19 (i.e., the change in real GDP (GDPE) divided by the shock to real public investment (IG)). The multiplier on GDP rises to 1.9 by the year 2010.

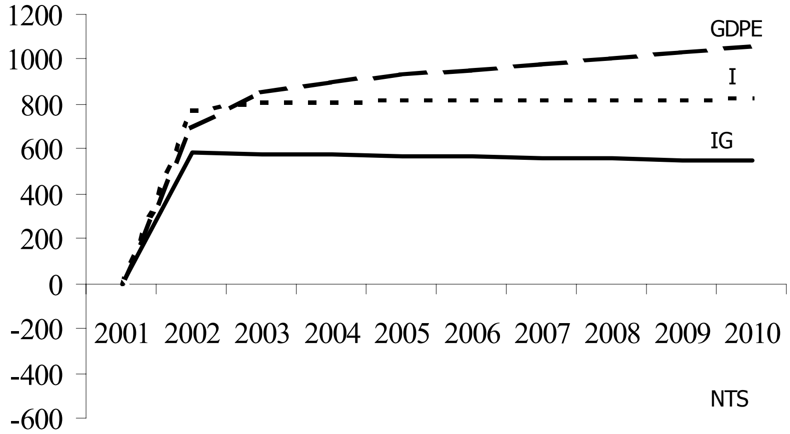
Once again, we must stress that the extra public expenditure to support increased public investment is financed by running a higher regional deficit. So, there is no fiscal crowding out due to higher tax rates or higher interest rates.

Table 5.7: Effects of a 10% rise in the level of public investment
(change relative to baseline, real zloty (1995))

Date	IG	I	GDPE	NTS	Multiplier
2001	0.00	0.00	0.00	0.00	0.0
2002	581	774	693	-332	1.19
2003	579	805	853	-386	1.47
2004	575	812	900	-397	1.56
2005	570	814	929	-400	1.63
2006	566	815	955	-402	1.69
2007	561	817	980	-402	1.75
2008	557	818	1005	-403	1.80
2009	553	820	1031	-403	1.86
2010	549	822	1057	-403	1.92

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

Figure 5.3: Effects of a 10% rise in the level of public investment (IG)
(Change relative to baseline, thousands)

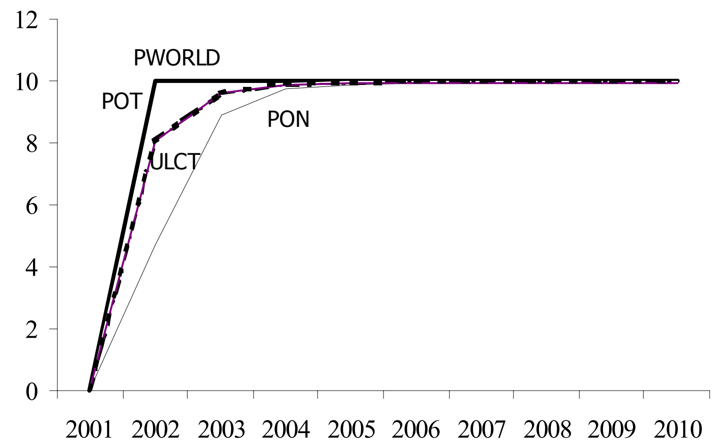


(iv) A shock to all exogenous price levels

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

Figure 5.4 shows the response of Polish prices and costs. The consumption price (PCONS) and the price of manufacturing output (POT) respond almost immediately and approximately one-to-one. Likewise unit labour costs (ULCT) respond nearly one by one, and there is little or no shift in real unit labour costs after the first two periods. Only the market service sector price (PON) responds with a lagged adjustment, and rise by 8.5 per cent immediately, and almost full adjustment is achieved after a few periods.

Figure 5.4: Effects of a 10% rise in all external price levels (PWORLD, etc.)
(percentage change relative to baseline)



Conclusions on responses to shocks

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

[6] Modelling impacts of EU Structural Funds

6.1 Introductory remarks

The EU Structural Funds came into existence from the year 1989 onwards as a result of the major reforms and extensions of EU regional policy that were initiated in the context of planning for the development of the Single Market during the years 1985-88. The political rationale behind the CSF arose from the fear that not all EU member states and regions were likely to benefit equally from the Single Market. In particular, the less advanced economies of the Southern, Western and Eastern periphery (mainly Greece, Ireland and Portugal, together with significant regions in Spain, Italy, Germany and the UK), were felt to be particularly vulnerable unless they received increased development aid. With the accession of ten new states to EU membership from the year 2004, the regional aid process (referred to as National Development Planning) is about to be extended. When Poland becomes a member of the EU, it will be designated as an Objective 1 country (i.e., GDP per head lower than 75 per cent of the EU average) and will therefore become eligible for EU Structural Fund aid.

In this section we present an *ex-ante* evaluation of the likely impact of the NDP policies that will be in effect for the years 2004-06 on the Polish economy. The analysis of the macroeconomic impacts of the NDP requires the use of an economic model whose main purpose is to formalise views about how the Polish economy is likely to evolve in the medium term and how the NDP investment policies and expenditures are likely to improve the productivity and growth of the economy. Without such a model it would be impossible to carry out quantitative analysis of NDP impact at an aggregate level. For this purpose, the new macro model of the HERMIN type has been developed for Poland.

6.2 The principles of NDP macroeconomic evaluation

Macroeconomic impact evaluation operates at the most aggregated level of analysis. Consequently, the data from the Polish NDP needs to be aggregated into essentially three major conceptual policy initiatives:

i. Investment in improved <u>physical infrastructure</u>;
ii. Investment in improvements in <u>human resources</u> (education and training); and
iii. Expenditures on direct <u>aid to the productive sector</u> (investment support, management training in the widest sense, etc.).

To the extent that the Polish HERMIN model provides a credible representation of the way in which CSF-type policies are likely to affect the economy, some reasonably robust quantitative conclusions concerning NDP impacts can be inferred. The model can be used to explore the extent that the aggregate NDP 2004-06 may have a greater impact than the sum of its individual parts, due to the existence of spill-over and externality effects that are difficult to conceptualise and measure at the more disaggregated level of analysis.

While the model-based macroeconomic analysis holds out the promise of quantification of NDP impacts, it is important not to over exaggerate the potential of this complex methodology. The manner of incorporating the NDP investment mechanisms into the HERMIN model draws on very recent economic research that itself has only begun to address the questions of the relationship between increased public investment and the consequences for economic growth and development. Consequently, the present analysis should be regarded as preliminary and exploratory.

In what follows, we first describe in summary form how the detailed NDP policy initiatives were aggregated into three main categories mentioned above: namely, physical infrastructure, human resources and direct aid to productive sectors. We then describe our methodology for arriving at a quantification of NDP impacts. It needs to be stressed that we make a crucial assumption regarding the magnitudes of the externality or spill-over parameters that capture the effectiveness of the NDP in terms of its long-term impacts on the level of activity and productivity. The higher the values that we assume for these parameters, the better the likely long-term NDP impacts on the level of activity and productivity. Due to the absence of empirical studies of the impacts of infrastructure and human capital on the performance of the Polish economy, we are unable to select parameter values with a high degree of precision. However, we make best use of existing research findings, and attempt to isolate results that are most relevant to the Polish economy, even when the published research was based on other regions and countries.

Next we present the results of our simulations of the impact of NDP-related investments and other expenditures on the Polish economy for the period 2004-2010, i.e., for four years after the NDP terminates in 2006. This requires us to make an explicit stylised assumption about the likely format of the NDP that will follow the initial 2004-06 NDP programme.[20] This subsection is followed by a note on the impacts of the Polish NDP 2004-06 in conjunction with a hypothetical continuation NDP 2007-13. We conclude with executing a brief sensitivity analysis with respect to the size of the spill-over effects.

6.3 Simplifying and aggregating the NDP investment programmes

Before any macroeconomic evaluation of the NDP can take place, the individual investment and other programmes need to be amalgamated into more aggregate economic categories. There are various reasons for this. First, although it is necessary to present the NDP in great administrative detail for the purposes of organisation and implementation, there is less rationale for this detail from an economic impact evaluation perspective. Second, if we aggregate the NDP expenditures into economically meaningful categories, we can make use of research on the impacts of public investment on the performance of the private sector.

The most useful and logical categories for aggregating the NDP are as follows:

i. Investment expenditures on physical infrastructure;
ii. Investment expenditure on human resources;
iii. Expenditures on direct production/investment aid to the private sector (i.e., manufacturing, market services and agriculture).

For each of these economic categories of NDP investment expenditure, there are three possible sources of funding:

[20] In the simulations presented below, we assume that the NDP expenditures are projected as continued at their nominal 2009 values. This is undoubtedly an understatement of the more likely situation where these NDP expenditures will be increased significantly in the NDP that follows the 2004-06 programme.

i. EU transfers in the form of subventions to the domestic public authorities, as set out in the NDP treaties;
ii. Domestic public sector co-financing, as set out in the NDP treaties;
iii. Domestic private sector co-financing, as set out in the NDP treaties.

The actual data from the Polish NDP is shown in Table 6.1 below. Although the total expenditure allocated to the NDP by the EU authorities, the Polish government and the Polish private sector are exactly those contained in the NDP, the allocations between the three main economic categories is judgemental.

6.4 An NDP impact quantification methodology

NDP investment programmes influence the economy through a mixture of supply and demand effects. Short term demand (or Keynesian) effects arise in the models as a consequence of increases in the expenditure and income policy instruments associated with NDP policy initiatives. Through the "multiplier" effects contained in the Polish HERMIN model, there will be knock-on changes in all the components of domestic expenditure (e.g., total investment, private consumption, the net trade surplus, etc.) and the components of domestic output and income.

These demand effects are of transitory importance and are not the *raison d'etre* of the NDP, but merely a side-effect. Rather, the NDP interventions are intended to influence the long-run supply potential of the economy. These so-called "supply-side" effects arise through policies designed to:

(i) increase investment in order to improve physical infrastructure as an input to private sector productive activity;

(ii) increase in human capital, due to investment in training, an input to private sector productive activity;

(iii) channel public funding assistance to the private sector to stimulate investment, thus increasing factor productivity and reducing sectoral costs of production and of capital.

Thus the NDP interventions are designed in order to improve the aggregate stock of public infrastructure and of human capital, as well as the private capital stock. Providing more and better infrastructure, increasing the quality of the labour force, or providing investment aid to firms, are the mechanisms through which the NDP improves the output, productivity and cost competitiveness of the economy. In a certain sense, these policies create conditions where private firms enjoy the use of additional productive factors at no cost to themselves. Alternatively, they may help to make the current private sector inputs - that firms are already using - available to them at a lower cost, or the general conditions under which firms operate are improved as a consequence. In all these ways, positive externalities may arise out of the NDP interventions.

Recent advances in growth theory have addressed the role of spill-overs or externalities which arise from public investments, for example in infrastructure or in human capital. Furthermore this literature has investigated how technical progress can be affected directly through investment in training, research and development. Here too externalities arise when innovations in one firm are adopted elsewhere, i.e., when such innovations have public good qualities.

Two types of beneficial externalities are likely to enhance the mainly demand-side (or neo-Keynesian) impacts of well designed investment, training and aid policy initiatives. The first type of externality is likely to be associated with the role of improved infrastructure and training in boosting output directly. This works through mechanisms such as attracting productive activities through foreign direct investment, and enhancing the ability of indigenous industries to compete in the international market place. We refer to this as an output externality since it is well known that the range of products manufactured in developing countries changes during the process of development, and becomes more complex and technologically advanced.

The second type of externality arises through the increased total or embodied factor productivity likely to be associated with improved infrastructure or a higher level of human capital associated with training and education. We refer to this as a factor productivity externality. Of course, a side effect of increased factor productivity is that, in the restricted context of fixed output, labour is shed. The prospect of such "jobless growth" is particularly serious in Poland where the recorded rate of unemployment and well as the rate of hidden unemployment is already very high and rising. Thus, the factor productivity externality is a two edged process: industry and market services become more productive and competitive, but labour demand is weakened if output is fixed. However, on the plus side, factor productivity is driven up, real incomes rise, and these effects cause knock-on multiplier and other benefits throughout the economy. Consequently, the role of the output externality is more unambiguously beneficial: the higher it is, the faster the period of transitional growth to a higher income plateau. Taken together, these two externality effects have the potential to produce beneficial impacts in terms of an increased level of economic activity and increased employment.

The elasticities, particularly in relation to infrastructure, have been chosen on the basis of an exhaustive literature review (details of which are available in Bradley, Kangur and Morgenroth, 2001). The empirical literature suggests that the values for the elasticity of output with respect to increases in infrastructure are likely to be in the region between 5 and 40 per cent, with Poland probably characterised by values nearer the upper end of the scale. With respect to human capital, elasticities in the same range also appear reasonable.[21] Further explanation of the way in which the NDP impacts were modelled are contained in Appendix 2, and a short review of the international research findings on the magnitudes of the spill-over effects is contained in Appendix 3.

[21] For example, a one per cent rise in the stock of physical infrastructure is assumed to be associated with an η per cent rise in manufacturing output, where the elasticity η lies between 0.05 and 0.40.

Table 6.1: Original data for the Polish National Development Plan, 2004-2006 (euro)
(data after EU summit in Copenhagen, December 12-13, 2002)

	EU FINANCING						DOMESTIC PUBLIC FINANCING						DOMESTIC PRIVATE FINANCING					
	2004	2005	2006	2007	2008	2009	2004	2005	2006	2007	2008	2009	2004	2005	2006	2007	2008	2009
IGVCSF	103.4	523.0	1089.8	1285.7	792.0	152.7	34.7	186.8	392.9	473.3	294.0	61.4	31.5	169.8	357.1	430.2	267.2	55.9
GTRSF	63.9	232.1	455.6	460.7	264.5	13.6	26.4	97.4	191.9	195.8	113.0	6.9	14.6	76.4	159.9	190.6	117.9	23.7
TRIT	13.8	74.4	156.5	188.5	117.1	24.5	4.4	23.8	50.1	60.3	37.5	7.8	18.2	98.0	206.1	248.3	154.2	32.2
TRIN	13.8	74.4	156.5	188.5	117.1	24.5	4.4	23.8	50.1	60.3	37.5	7.8	18.2	98.0	206.1	248.3	154.2	32.2
TRIA	17.6	94.9	199.6	240.5	149.4	31.2	5.9	31.8	66.8	80.5	50.0	10.5	19.9	107.5	226.0	272.2	169.1	35.3
Total	**212.6**	**1180.1**	**2439.2**	**2822.9**	**1725.3**	**306.1**	**91.2**	**446.5**	**926.0**	**1080.1**	**662.3**	**121.7**	**169.3**	**910.1**	**1913.0**	**2302.3**	**1429.7**	**297.9**

Note:

The Polish NDP contains seven Operational Programmes, as follows:

SOP 1: IMPROVEMENT OF COMPETITIVENESS OF THE ECONOMY
SOP 2: HUMAN RESOURCES DEVELOPMENT
SOP 3: RESTRUCTURING AND MODERNISATION OF THE FOOD SECTOR AND RURAL DEVELOPMENT
SOP 4: FISHERIES AND FISH PROCESSING
SOP 5: TRANSPORT-MARITIME ECONOMY
INTEGRATED REGIONAL OPERATIONAL PROGRAMME (IROP)
OPERATIONAL PROGRAMME TECHNICAL ASSISTANCE

In Table 6.1 above, we have allocated the investment expenditures from these seven Operational Programmes to the three economic categories: physical infrastructure, human capital, and direct aid to the productive sectors.

How enduring are the beneficial externality elasticities likely to be ? The infrastructure deficit in Poland is known to be very large, as documented in the draft Polish NDP document, and is unlikely to match up to the level pertaining in the more developed EU countries until well after the year 2015. Given this fact, as well as the fact that there are substantial returns to the elimination of bottlenecks which will take some time to accomplish, it is quite reasonable to expect that the chosen elasticities will capture the benefits properly over the time period for which the simulations have been carried out, i.e., 2004-2010. For the same reasons it is unlikely that diminishing returns will set in.

6.5 Simulating the macroeconomic impacts of NDP 2004-2006

(i) Methodology and assumptions

The NDP consists of major public investment programmes aimed at improving the quality of physical infrastructure, human resources (or human capital), as well as providing direct grant aid to the three main productive sectors (manufacturing, market services and agriculture). In this section we analyse the impacts of the NDP on a range of macroeconomic and macro-sectoral variables with the aid of the Polish HERMIN model.

The context in which we execute this macro-sectoral impact evaluation exercise is as follows:

i. We carry out a model simulation starting in the year 2001, the last year for which we have actual data on the Polish economy, and three years before NDP 2004-06 is to be implemented. We continue the simulation out to the year 2010, i.e., four years after the termination of NDP funding commitments. For this baseline simulation, we set the NDP expenditures at zero, and make a series of other forecasting assumptions on the external environment for Poland, and the non-NDP Polish policy environment. No other changes are made., and no attempt is made to design a "substitute" domestically funded public investment programme that would have replaced a "missing" NDP 2004-06. This is a very artificial assumption, since in the absence of the NDP there almost certainly would have been a substitute domestically funded public investment programme, albeit smaller in magnitude.[22]

ii. We then carry out a second simulation, where we now set the NDP investment expenditures at their actual values (as shown in Table 6.1) and make a series of assumptions concerning the manner in which the NDP supply-side (or spill-over) impacts are likely to occur. Unless otherwise stated (as in the sensitivity analysis reported at the end of the section), we assume the following values for the crucial externality elasticities:

(a) Output elasticities (infrastructure and human capital)	0.40
(b) Productivity elasticities (infrastructure and human capital)	0.20

iii. We "extract" the NDP 2004-06 policy shocks, by comparing the "with-NDP" simulation and the "without NDP" simulation.

[22] We note that the "payments" NDP data are used, and not the "commitments". Hence, the expenditures for NDP 2004-06 extend into the following three years, i.e., 2007, 2008 and 2009. After the year 2009, the NDP expenditures were projected unchanged at their 2009 nominal values.

iv. Using the above elasticities, we experiment with three versions of the NDP. The first (referred to as the "total" NDP) includes EU, local public and private co-finance. The second (referred to as the "public" NDP) only includes EU finance and local public co-finance. The third (referred to as the "EU" NDP) only includes the EU finance.

v. It might be held that, in the presence of such large-scale public policy shocks, the underlying structure of the economy would change and that the use of Polish HERMIN model calibrated with NDP-inclusive data is invalid (the so-called "Lucas critique" of the use of econometric models to analyse policy impacts). However, the Polish HERMIN model contains explicit sub-models of the structural changes that are associated with the operation of the NDP, so the validity of the Lucas critique is weakened.

To assist in the interpretation of the CSF simulation results, it is useful to keep some summary measures in mind. The total size of the NDP relative to GDP is shown in Table 6.2. The NDP expenditures have been calculated in national currency (Zloty). In terms of the size of the investment shock, the "total" NDP is the largest of the three variants, since it includes the EU, the domestic public co-finance and the domestic private co-finance. At its peak in the year 2007 the size of the increased investment is 1.67 per cent of GDP. The "public" NDP shock is an intermediate case (1.16 per cent of GDP at its peak), and the "EU" NDP is the smallest (0.86 per cent of GDP at its peak).

Table 6.2: NDP expenditure expressed as a percentage of GDP

	Total NDP	Public NDP	EU NDP
2003	0.00	0.00	0.00
2004	0.18	0.13	0.10
2005	0.81	0.58	0.43
2006	1.55	1.10	0.81
2007	1.67	1.16	0.86
2008	0.96	0.67	0.49
2009	0.17	0.11	0.08
2010	0.15	0.10	0.07

A measure of the growth in the stock of physical infrastructure relative to the case where there had been no NDP (i.e., the no-NDP baseline), denoted by KGINFR, is shown in Table 6.3. A measure of the growth in the "stock" of human capital relative to its non-NDP baseline (KTRNR), is also shown in Table 6.3. [23] The increases in the stock of physical infrastructure and in the stock of human capital are similarly ranked. Thus, by the year 2010 the stock of infrastructure increases by 5.12 per cent relative to the no-NDP baseline, and the stock of human capital by 0.90 per cent, as a result of the "total" NDP shock.

[23] The manner in which the stock of physical infrastructure and of human capital are defined is described in the Appendix. It should be noted that human capital is measured as an accumulation of years of education and training. Issues of quality and relevance of the education/training are not addressed. If the quality or relevance is low, the "effective" years would need to be be reduced.

Table 6.3: Percentage increase in "stock" of physical infrastructure (KGINFR) and stock of human capital (KTRNR) relative to the no-NDP baseline stock

	Total NDP		Public NDP		EU NDP	
	KGINFR	KTRNR	KGINFR	KTRNR	KGINFR	KTRNR
2003	0.00	0.00	0.00	0.00	0.00	0.00
2004	0.17	0.05	0.14	0.04	0.10	0.03
2005	0.99	0.22	0.80	0.18	0.59	0.13
2006	2.57	0.54	2.07	0.43	1.53	0.31
2007	4.27	0.83	3.44	0.66	2.52	0.47
2008	5.14	0.97	4.14	0.77	3.03	0.54
2009	5.13	0.94	4.13	0.74	3.02	0.52
2010	5.12	0.90	4.11	0.71	3.01	0.50

(ii) HERMIN model simulations of NDP impacts

In Table 6.4 we show the impact of the NDP on aggregate real GDP at market prices (as a percentage change relative to the no-NDP baseline), and on the unemployment rate (as a difference relative to the no-NDP baseline). This simulation captures both the direct demand-side (or Keynesian) impacts as well as additional supply-side impacts that are associated with the improvement in infrastructure and human resources.

Table 6.4: Aggregate NDP 2004-2006 impacts on GDP and unemployment

	Total NDP		Public NDP		EU NDP	
	GDPM	UR	GDPM	UR	GDPM	UR
2003	0.00	0.00	0.00	0.00	0.00	0.00
2004	0.22	-0.14	0.17	-0.10	0.12	-0.08
2005	1.13	-0.71	0.83	-0.51	0.60	-0.37
2006	2.51	-1.48	1.83	-1.05	1.32	-0.76
2007	3.33	-1.77	2.43	-1.25	1.74	-0.90
2008	2.83	-1.15	2.10	-0.81	1.48	-0.56
2009	1.56	-0.27	1.20	-0.18	0.82	-0.10
2010	1.22	-0.05	0.95	-0.02	0.63	0.02

GDP: Percentage change from no-NDP baseline; UR: Change from no-NDP baseline

For the "total" NDP the impact on GDP peaks in the year 2007 at 3.33 (i.e., the level of Polish GDP is likely to be 3.33 per cent higher as a result of the NDP). In the same year, the rate of unemployment is cut by almost 2 percentage points (i.e., if the rate of unemployment had been X percent of the labour force in the no-NDP simulation, it would be (X-1.77) per cent in the "total" NDP simulation). As we move across Table 6.4 from the "total", to the "public" and finally to the "EU" NDPs, the effects become more modest. Note that by the year 2010 – by which time the NDP expenditures are assumed to be frozen at their low 2009 values, the fall in the level of unemployment is very much reduced. This comes about due to the induced rise in productivity that is associated with the efficiency-enhancing effects of the NDP programmes. However, it should be remembered that the only policy alteration that we introduce into the model is the NDP investment programmes. In reality, other changes will accompany the NDP, e.g., the restructuring of the Polish economy and its opening to increased trade within the single European market. So, the above results need to be interpreted carefully as representing only one element of the impact of EU entry on the Polish economy.[24]

In Table 6.5 we show the impacts of the "total" NDP on the level of real sectoral output. The impacts peak in the year 2008 at 5.10 per cent for manufacturing, 3.23 for market services in the year 2007, 1.47 for public sector output in the year 2006 and by 3.48 for total GDP at factor cost in the year 2007. It should be noted that even by the year 2010 the level of GDP is still higher than for the no-NDP baseline case by 1.35 per cent, even though the continuing injection of NDP funding is very small (i.e., about 0.15 per cent of GDP from Table 6.2 above).[25]

Table 6.5**:** Total NDP impacts on sectoral GDP (% change over no-NDP baseline)

	OT	ON	OG	GDPFC
2003	0.00	0.00	0.00	0.00
2004	0.26	0.25	0.22	0.24
2005	1.44	1.24	0.79	1.20
2006	3.42	2.62	1.47	2.63
2007	5.05	3.23	1.45	3.48
2008	5.10	2.29	0.80	2.94
2009	3.65	0.82	0.07	1.64
2010	3.25	0.47	0.06	1.35

OT denotes output in manufacturing;
ON denotes market services;
OG denotes public services;
GDPFC denotes total GDP at factor cost;

In Table 6.6 we show the impacts of the "total" NDP on sectoral employment numbers (in thousands). The impact on manufacturing employment numbers peaks in the year 2007 at 126 000 extra jobs. Even by the year 2010, there is still an increase of almost 62 000 jobs relative to the baseline (no-NDP) level of employment. For market services, the peak increase is 167 000 extra jobs, but this turns negative as the NDP is wound down. The reason for this is that the NDP also drives up productivity in both manufacturing and market services. It also drives up output in both sectors, but the percentage rise in manufacturing output is considerably higher than that of market services. So, if nothing else changes except the NDP expenditures, then labour is shed. Also, the bulk of the construction activity is carried out within the market services sector (in the building and construction sub-sector), and this activity effectively ceases after 2008.

The net effect is a reduction in the rise in employment numbers after the year 2008 and a consequential reduction in the cut in unemployment numbers (i.e., from a peak reduction of 300 000 to a more modest reduction of 9 000 by the year 2010. However, it must be realised that this is a rather artificial simulation, for two reasons. The first was considered above in the

[24] See ESRI (1997) for an account of the combined analysis of NDP and Single Market impacts for Greece, Ireland, Portugal and Spain.

[25] The rise in non-market sector output is associated with those elements of the NDP activities that will be executed within the secor (e.g., income transfers to trainees and trainers, building and construction activities, etc.). However, we take a rather pessimistic view on the output effects on the agriculture sector and assume that the rural programmes will produce enhanced welfare rather than increased output. This assumption will need to be re-examined when more information from the qualitative ex-ante NDP evaluations become available.

discussion of Table 6.4 (i.e., the missing Single European Market effect). The second concerns the assumption that NDP aid will be at a very low level after 2009, when in fact it is more likely to be greatly expanded.

Table 6.6**:** Total NDP impacts on sectoral employment and unemployment (change from no-NDP baseline)

	LT	LLN	L	U
2003	0.00	0.00	0.00	0.00
2004	7.38	15.62	23.96	-23.96
2005	39.38	76.81	119.71	-119.71
2006	90.15	153.45	250.18	-250.18
2007	126.07	167.18	299.75	-299.75
2008	116.11	75.04	194.73	-194.73
2009	73.56	-28.52	45.35	-45.35
2010	62.47	-53.82	8.93	-8.93

LT denotes employment in manufacturing (thousands); LLN denotes employment in market services (thousands)
L denotes total employment (thousands); U denotes numbers unemployed (thousands)

In Table 6.7 we decompose the "total" NDP impacts for manufacturing. We have already noted the increase in the level of output and employment. But in Table 6.7 we also see that the level of productivity (LPRT) increases steadily, and peaks at a rise of 1.32 per cent in the year 2008. In the absence of any other positive shock (i.e., over and above the NDP), this is likely to diminish the employment increase over time. In the case of the market services sector, we saw that the level of employment actually fell below the no-NDP level at the end of the simulation period, due to NDP-induced increases in productivity.

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Table 6.7: Total NDP impacts on manufacturing sector: (% change over "no-NDP" baseline)

	OT	LT	LPRT	IT
2003	0.00	0.00	0.00	0.00
2004	0.26	0.25	0.02	0.66
2005	1.44	1.31	0.13	3.40
2006	3.42	2.96	0.45	7.16
2007	5.05	4.09	0.92	9.03
2008	5.10	3.73	1.32	6.96
2009	3.65	2.34	1.28	3.45
2010	3.25	1.96	1.26	3.02

OT denotes output in manufacturing; LT denotes manufacturing employment;
LPRT denotes labour productivity; IT denotes manufacturing investment.

In Table 6.8 we show the changes in the public sector borrowing requirement, the national debt and the net trade surplus, all expressed as a percentage of GDP. It is of interest to note that the "total" NDP relaxes the Polish borrowing requirement (by 0.80 per cent of GDP in the year 2007 relative to the no-NDP baseline), causes a fall in the national debt (by 2.85 per cent of GDP in 2008 relative to the no-NDP baseline), and causes a decline in the net trade surplus (by 0.63 in 2007 relative to the no-NDP baseline). The small but beneficial impact on the public sector borrowing requirement (expressed as a percentage of GDP) is cused by the fact that much of the NDP financing comes in the form of either a grant from the EU or in the form of private sector financing. The induced boost to the economy helps finance the Polish public sector co-finance out of increased tax revenue in the context of fixed tax rates.

Table 6.8: Total NDP impacts on public sector deficit (GBORR)
and net trade surplus (NTSVR)
(percentage of GDP, deviation from baseline)[26]

	GBORR	RDEBT	NTSVR
2003	0.00	0.00	0.00
2004	-0.05	-0.15	-0.07
2005	-0.25	-0.79	-0.31
2006	-0.58	-1.87	-0.59
2007	-0.80	-2.74	-0.63
2008	-0.72	-2.85	-0.35
2009	-0.43	-2.45	-0.06
2010	-0.25	-2.35	0.02

In Table 6.9 we show the NDP impacts on the three main expenditure aggregates (i.e., private consumption, public consumption, total investment and total GDP). Thus, private consumption rises by 2.54 per cent over the baseline level in the year 2007; public consumption by 1.11 per cent in the year 2006; and total investment by almost 9 per cent in the year 2007. In the next years these increases fall off, but there remains a modest enduring increase out to the year 2010.

Table 6.9: Total NDP impacts on expenditure:
(% change over "no-NDP" baseline)

	CONS	G	I	GDPE
2003	0.00	0.00	0.00	0.00
2004	0.15	0.16	0.80	0.22
2005	0.78	0.60	3.93	1.12
2006	1.83	1.11	7.80	2.48
2007	2.54	1.10	8.88	3.30
2008	2.20	0.61	5.39	2.80
2009	1.11	0.05	1.27	1.54
2010	0.52	0.05	0.92	1.21

CONS denotes private consumption; G denotes public consumption;
I denotes total investment; GDPE denotes gross domestic expenditure.

We conclude by showing in Table 6.10 the impacts of the "total" NDP on prices, wages and unit labour costs. Initially, the NDP induces a small increase in the level of prices and wages above the no-NDP baseline level. But the price rise is reversed by the year 2006. In the case

[26] Note: A "+" sign indicates a deterioration (or rise) in the borrowing requirement (GBORR) but an improvement (or rise) in the net trade surplus (NTSVR), both expressed as a percentage of GDP.

of wage rates, the modest levels rise peaks in 2006 at 0.25 per cent, and remains positive (but small) out to the year 2009. However, nominal and real unit labour costs fall, and serve to increase Polish competitiveness. This is mainly driven by the NDP-induced rise in labour productivity in the manufacturing and market services sectors (see Table 6.7 above).

Table 6.10: Total NDP impacts on prices and wage rates:
(% change over "no-NDP" baseline)

	PCONS	WT	ULCT	RULCT
2003	0.00	0.00	0.00	0.00
2004	0.00	0.01	0.00	0.00
2005	0.00	0.07	-0.06	-0.03
2006	-0.05	0.18	-0.27	-0.15
2007	-0.21	0.25	-0.67	-0.38
2008	-0.45	0.20	-1.10	-0.62
2009	-0.59	0.04	-1.22	-0.69
2010	-0.64	-0.03	-1.27	-0.72

PCONS denotes consumer price; WT denotes wage rate in manufacturing;
ULCT denotes unit lab costs in manufacturing;
RULCT denotes real labour costs in manufacturing.

(iii) Sensitivity analysis of NDP 2004-2006 impacts

The core of the NDP interventions is designed to influence the supply-side of the Polish economy. Earlier in this section, as well as in Appendixes 2 and 3 below, we described how output and factor productivity externalities were incorporated to the system of model equations, which serve to link the NDP interventions directly with the supply-side of the economy.

If we could base our choice of externality elasticities firmly on local Polish research then we could propose specific elasticity values that were appropriate for the Polish model simulations. Unfortunately we do not have access to such research findings. We are forced to fall back on the international literature, and make use of findings in a range of countries that have similarities with the Polish economy.

The international empirical literature, although vast, is somewhat ambiguous about the appropriate magnitude of the externalities. Different researchers use different methodologies, and arrive at different conclusions. Faced with this situation, there are two possible strategies. The first would be to wait until the research results are available in Poland and to stand aside from any attempt to quantify the likely macroeconomic impacts of the NDP. The second would be to carry out the macroeconomic evaluation exercises with a range of externality elasticities and to exercise judgement on the most appropriate values for Poland based on a wide range of information about the local situation.[27]

[27] For example, in the case of the Irish CSF, there is evidence that suggests that the ESF training schemes – as implemented by the State Training Agency - were reasonably well targeted, closely integrated with other economic development policies, and were reasonably effective (Honohan (ed.), 1997; Denny, Harmon and O'Connell (2000)). This might suggest that externality elasticities near the top of the international range might be appropriate. However, in the case of the Greek CSF, the

A sensitivity analysis needs to be carried out to explore how the NDP impact changes as the two types of externalities – with respect to physical infrastructure and with respect to human capital - are varied from low to high values. For this exercise, the numbers shown in table 6.11 have been used.

Table 6.11: Elasticities used in sensitivity analysis simulations

		Factor productivity elasticities		
		0.00	0.20	0.40
Output elasticities	0.00	Zero – Zero		
	0.20		Medium – Medium	
	0.40		*High – Medium***	High - High

**Note: Simulations reported in Section 6.5 used the high-medium combination

It should be recalled that in the simulations reported in the previous section, the "high-medium" combination was used throughout the analysis, i.e., a high value of the output elasticity and a medium value of the productivity elasticity.

In the case "zero - zero" elasticities we effectively only have the conventional Keynesian demand-side effect. Minor neoclassical effects (through shifting relative prices) can arise, but they are dominated by the straightforward Keynesian effects. We can anticipate what the model simulations will produce for this case. While the NDP is being implemented (i.e., while there are positive expenditure streams of NDP investment programmes), there will be demand-side (or Keynesian) impacts. But in the complete absence of "stock" effects (through the improved infrastructure and human capital), these demand-side impacts will rapidly return to zero.

In the case of the "high-high" combination, the supply-side effects become much more relevant, particularly over time as the stocks of physical infrastructure and human capital build up. Compared to the findings taken from the empirical literature, our high elasticities sometimes fall into the middle of the observed scale, but we deliberately adopted a conservative approach. Here we get the demand-side impacts while the NDP is being implemented, and this is accompanied by a gradual build up of supply-side impacts that continue even after the NDP is wound down. Eventually depreciation effects set in and the economy will start converging back towards the original no-NDP baseline level of activity. But this is a long drawn out process, and will continue long after the terminal year of our simulations, namely the year 2010.

It would be possible to extend Table 6.11 to include all possible asymmetric options (e.g., of the "high-low" variety). But the optimum balance between investment in physical infrastructure and human resources is a topic that deserves detailed investigation, but we cannot pursue it further in this report. A balanced development of physical infrastructure appears to be the best option and has been adopted in most of the Objective 1 CSFs in the EU. The cases of the transition economies like Poland give rise to very special considerations. These economies are starting from a level of GDP per head very much lower than that of the less wealthy EU member states (Portugal and Greece), so there is a much

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limited information available on the extensive re-phasing (or "re-programming") of CSF 94-99 might suggest that difficulties may have arisen at the design and implementation stages of many of the Operational Programmes. This might suggest low externality elasticities.

greater potential for faster growth and catch-up if the NDP is well designed and other systems of internal economic governance operate efficiently and effectively. In the case of Poland, this points to externality elasticities at the higher end of the scale of injternational findings.

Table 6.12 presents the simulation results for three stylised NDP scenarios, namely a "zero-zero" choice of externality elasticities for physical infrastructure and human capital; a "medium-medium" choice, where both elasticities are assumed to take the values 0.20; and a "high-high" option, where both elasticities are assumed to take the values 0.40, i.e., values that are towards the upper range of results found in the international literature for developed OECD-type economies.

Table 6.12: Poland: zero, medium and high elasticities: impacts on GDP and unemployment

	ZERO-ZERO		MEDIUM-MEDIUM		HIGH-HIGH	
	GDPM	UR	GDPM	UR	GDPM	UR
	% dev from base	dev from base	% dev from base	dev from base	% dev from base	dev from base
2003	0.00	0.00	0.00	0.00	0.00	0.00
2004	0.22	-0.14	0.22	-0.14	0.22	-0.14
2005	1.06	-0.72	1.09	-0.68	1.12	-0.64
2006	2.23	-1.52	2.35	-1.37	2.47	-1.23
2007	2.69	-1.85	2.96	-1.53	3.24	-1.21
2008	1.84	-1.26	2.25	-0.78	2.67	-0.29
2009	0.54	-0.36	0.95	0.12	1.38	0.60
2010	0.21	-0.16	0.61	0.34	1.04	0.83

Moving from the left to the right (i.e., from "zero-zero" to "high-high" elasticity combinations) produces very significant boosts to the level of GDP towards the end of the simulation period. For example in the "zero-zero" combination, the level of GDP in the year 2010 is only 0.21 above the baseling (no-NDP) case. For the "medium-medium" case, the level ends up 0.61 per cent higher, and in the "high-high" case, 1.04 per cent higher. However, high human capital elasticities imply high productivity growth, and the "high-high" scenario has smaller cuts in unemployment than in the "low-low" case. In the "high-high" case, the end-period level of unemployment is actually higher than the baseline (by 0,83 percentage points), whereas in the "low-low" case, the end-period level of unemployment remains lower than the baseline (by 0.16 percentage points).

Although these simulations appear to be rather artificial, this kind of "jobless" growth (illustrated as one moves from left to right in Table 6.12) was actually observed in Ireland during the first CSF (1989-93) and for the first few years of the second CSF (1994-1999). But subsequently, Ireland experienced very high employment growth even in the presence of continuing very high growth in labour productivity. To understand this we would need to move outside the narrow analysis of NDP impacts and consider a wider range of policy initiatives that accompanied the CSF/NDP, e.g., policy towards attracting foreign direct investment, the Social Partnership that served to moderate inter-sectoral wage inflation (Nolan *et al*, eds., 2000), and the agglomeration effects that characterised the computer and pharmaceutical sectors that built up during the early part of the 1990s (see Bradley, 2001).

(iv) Impact of NDP 2004-06 in conjunction with a hypothetical continuation NDP 2007-13

The previous subsection of the following report presents the results of model simulations which examine the likely impacts of the Polish NDP 2004-06 in isolation from all other policy and external influences on the Polish economy that will undoubtedly occur during the period of implementation of NDP 2004-06.[28]

Thus, the beneficial impacts on the Polish economy of its progressive participation within the Single European Market (SEM) are ignored. Previous analysis of this aspect of EU integration for the poorer EU member states (Greece, Ireland and Portugal) has shown that the SEM is likely to bring much larger benefits than the NDP in isolation, particularly if the economy is able to restructure so as to take maximum advantage from new opportunities that are made available by the SEM (ESRI, 1997).[29] In addition, the potential benefits from restructuring of the agricultural sector, as well as from joining the euro zone are also ignored.

In this subsection we address an aspect of the NDP operating in isolation from the SEM, CAP reform and EMU. We note that the analysis contained in the previous subsection of the Section 6 makes the following very artificial assumptions:

(1) The NDP 2004-06 operates in isolation from all other policy and external influences;
(2) The NDP is a "once-off" event, and will be wound down and effectively discontinued by the year 2009;
(3) There will be no fuirtherfurther EU-aided NDPs after NDP 2004-06.

In the light of the experiences of the poorer (so called cohesion) states of the EU (Greece, Ireland and Portugal), it seems very likely that a new and expanded Polish NDP will be negotiated during the years 2005-06, and will be implemented for an extended period after 2006. For example, the first EU Community Support Framework (CSF) covered the period 1989-93. An expanded CSF was then designed that covered the years 1994-99. The present EU CSF covers the period 2000-2006.

If, as is very desirable, a new and enlarged NDP will operate within Poland for an extended period after 2006, then it is necessary to anticipate these events in a counterfacturalcounterfactual simulation, rather than designing strategy in a context that assumes there will be no future NDPs after 2006. To initiate discussion about these matters, we have carried out the following additional model simulation;

(1) We assume that there will be a new NDP after the year 2006, which will subsume the programmes of NDP 2004-06 for the years after 2006;
(2) We assume that this new NDP will operate over a six seven-year time horizon, for the period 2007-20123 at least;

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[28] We refer to NDP 2004-06, even though the expenditures will continue beyond the terminal year 2006, out to 2009. The period "2004-06" might be termed the planning period of the NDP. The period "2004-09" might be referred to as the implementation period of the NDP.

[29] However, the case of Greece shows that the benefits of the SEM are likely to be very small when the economy fails to restructure in an economically rational and optimal way (ESRI, 1997).

(3) We assume that the ability of the Polish economy to absorb and co-finance EU aid will be improved, and that the limit of NDP funding (EU, domestic public and domestic private) will rise to 2,0 or even 2,5 per cent of GDP.[30]
(4) Given the extent to which Polish GDP per capita is likely to lag behind that of the EU average, even after the year 20123, consistently we make the further assumption that NDP expenditures of approximately 2,0 or 2,5 per cent of GDP of the year 2013 will continue beyond the year 20123, to the terminal date of our model simulations, namely the year 2015.[31]

The results of these two simulation experiments are shown in Tables 6.13 and 6.14. In the case of Table 6.13, we make the assumption that the annual level of NDP funding for the period 2007-2013 will be at about 2 per cent of GDP. In the case of Table 6.14, we raise this to 2.5 per cent of GDP, a figure more in line with the experience of the EU cohesion countries during the period 1989-2006.

Table 6.13: Aggregate NDP impacts on GDP* and unemployment (UR**) - assumption: annual funding within NDP in the years of 2007-2013 on the level of 2 per cent of GDP

	Total NDP		Public NDP		EU NDP	
	GDPM	UR	GDPM	UR	GDPM	UR
2003	0,00	0,00	0,00	0,00	0,00	0,00
2004	0,22	-0,14	0,17	-0,10	0,12	-0,08
2005	1,13	-0,71	0,83	-0,51	0,60	-0,37
2006	2,51	-1,48	1,83	-1,05	1,32	-0,76
2007	3,83	-2,07	2,79	-1,47	2,00	-1,05
2008	4,62	-2,18	3,41	-1,53	2,43	-1,09
2009	5,09	-2,21	3,78	-1,56	2,67	-1,09
2010	5,53	-2,24	4,12	-1,57	2,90	-1,08
2011	5,99	-2,28	4,49	-1,60	3,14	-1,08
2012	6,47	-2,32	4,87	-1,62	3,39	-1,09
2013	6,97	-2,37	5,26	-1,66	3,65	-1,09
2014	7,22	-2,26	5,48	-1,57	3,78	-1,01
2015	7,27	-2,01	5,52	-1,36	3,75	-0,81

GDP: Percentage change from no-NDP baseline; **UR: Change from no-NDP baseline

[30] The share of total NDP expenditure in the Polish NDP 2004-06 peaked at 1.67 per cent of GDP in the year 2007 and falls to below 0.2 per cent by 2009.

[31] The assumption that a future NDP 2007-13 would terminate EU aid would also appear to be somewhat artificial. The EU cohesion countries (Greece, Ireland and Portugal) will have received EU aid for 16 years (starting from 1989) when the present programme period (2000-06) terminates. If Poland only starts to receive significant NDP aid in the year 2004, and is to receive it for a period comparable to the EU cohesion countries, then this would take us to the year 2020.

Table 6.14: Aggregate NDP impacts on GDP* and unemployment (UR**) - assumption: annual funding within NDP in the years of 2007-2013 on the level of 2,5 per cent of GDP

	Total NDP		Public NDP		EU NDP	
	GDPM	UR	GDPM	UR	GDPM	UR
2003	0,00	0,00	0,00	0,00	0,00	0,00
2004	0,22	-0,14	0,17	-0,10	0,12	-0,08
2005	1,13	-0,71	0,83	-0,51	0,60	-0,37
2006	2,51	-1,48	1,83	-1,05	1,32	-0,76
2007	4,57	-2,52	3,33	-1,79	2,39	-1,29
2008	5,66	-2,73	4,16	-1,92	2,97	-1,37
2009	6,30	-2,80	4,67	-1,98	3,31	-1,39
2010	6,85	-2,84	5,10	-2,00	3,59	-1,38
2011	7,43	-2,88	5,56	-2,02	3,89	-1,38
2012	8,04	-2,95	6,03	-2,06	4,20	-1,38
2013	8,67	-3,02	6,53	-2,11	4,53	-1,39
2014	8,99	-2,88	6,81	-2,01	4,70	-1,29
2015	9,22	-2,70	7,02	-1,87	4,82	-1,16

*GDP: Percentage change from no-NDP baseline; **UR: Change from no-NDP baseline

Compared to the previous analysis of NDP 2004-2006 – where we phased out the investment expenditures after 2006, the impacts are now considerably greater. Taking the case of the "total" NDP, in Table 6.13 the impact is to raise the level of Polish GDP by 7.27 per cent above the baseline (no-NDP) level. In the case of Table 6.14, this becomes an increase of 9.22 per cent above the baseline (no-NDP) level. The reduction in the level of unemployment are equally strong, ranging from 2.4 percentage points (Table 6.13) to 3.0 percentage points (Table 6.14).

These results can be placed in context as follows. If we assumed that the Polish economy were to grow at roughly the EU average growth rate over the period 2003-2015, in the absence of NDP aid, then Poland would make no progress towards the cohesion objective. If that were the case, then in the presence of NDP aid for the period 2004-2006 (the planned NDP programme) and 2007-2013 (our hypothetical continuation NDP), then Poland could reduce the gap between its living standards and those of the EU (as measured by GDP per capita) by between 7 and 9 percentage points.

The cohesion progress suggested by Tables 6.13 and 6.14 could be thought of as a worst case scenario. In practice, there are likely to be many other changes in the structure of the Polish economy (e.g., agricultural reforms, industrial strategy, increased inward foreign direct investment) as well as the policy environment (fiscal reforms, labour market developments, the Single European Market, Economic and Monetary Union, etc.) that are likely to add significantly to the achievement of the cohesion objective. The broadest lesson to be drawn from this experimental NDP impact analysis is that structural change in an economy – involving openness, institutional quality, etc. – is driven by the NDP interventions, but also by wider domestic and international forces. The NDP will serve to accelerate these changes, but it is the wider challenges of EU membership that will probably dominate in promoting cohesion.

[7] Conclusions and future developments of the model

The objective of this paper has been to introduce and use the HERMIN modelling framework and methodology to construct, estimate and test a four-sector macro model of Poland. We started, in Section 2, with the discussion of the modelling database and with its help we illustrated the transition process of the Polish economy by presenting some stylised facts that we considered important to this process and to the model structure.

After reviewing the theoretical background of the HERMIN model, with its neo-Keynesian and neo-classical features in section 3, we devoted our attention to discussing suitable characteristics of the model and outlined its structure. In Section 4 we looked in detail on individual behavioural equations from the point of view of the calibration process. We discussed their functional forms on the basis of the underlying theory and principles that guided us during the actual calibration of each of them, and we also commented on the numerical values of the parameters obtained by this procedure. The common problem appearing in the estimation of many model equations has been a lack of relevant data observations. In several cases we were, therefore, forced to simplify the original behavioural hypotheses either by dropping some of explanatory variables or by imposing additional constraints on the value of estimated parameters.

In Section 5 we discussed the 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. We then tested the model by constructing an out-of-sample projection, in order to explore the likely evolution of the Polish economy during the period 2000-2010. Finally, we described how we carried out several policy oriented shocks to key exogenous variables. 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 transition and subsequent integration 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 is assumed 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 Polish economy. Thus, the main task of this paper has been to present the model and explore its properties and uses.

In section 6 we used the model to examine how EU Structural Funds (in the form of the Polish National Development Plan of 2004-2006) is likely to affect the nature and speed of the transition process in the context of the early years of Poland's membership of the EU. Further research on the model will be oriented towards the incorporation of a range of growth mechanisms into the model, and comparison of convergence profiles of the Polish economy to other studies on this subject (e.g. Fisher, Sahay and Végh, 1998). 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 CSF program on economic performance of several peripheral countries of the EU.

The new Polish 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 Poland, we can draw on its insights in order to improve our 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 very stylised picture of the economy. Ideally we would like to learn more by:

i. Expanding the model in order to examine the important sub-components within manufacturing and market services;[32]

ii. Modelling the agriculture sector in more detail, in order to move beyond our 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 Polish banking system now implies that Polish consumers are no longer completely liquidity constrained.

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.

More ambitiously, we would like to extend the model towards the regional economies of Poland, and examine the serious regional development problems that must be tackled with the aid of EU Structural Funds and local public and private co-finance. This will be a major challenge, but the two regional versions of the HERMIN model – East Germany and Northern Ireland – have already provided useful insights into these challenges.[33]

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[32] 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 transfort and communications, wholesale and retail distribution, and a residual category that includes a wide range of professional and other services.

[33] See Bradley, Morgenroth and Untiedt (2001) for East Germany and Bradley and McLaughlin (2002) for Northern Ireland.

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Appendix 1: Analytics of the traded/non-traded model

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

i. Goods produced domestically are perfect substitutes for goods produced elsewhere, so that prices (mediated through the exchange rate) cannot deviate from world levels, and

ii. Firms are able to sell as much as they desire to produce at going world prices. The latter is arguably an undesirable implication, and will be further discussed later. Note that it rules out Keynesian phenomena right from the start.

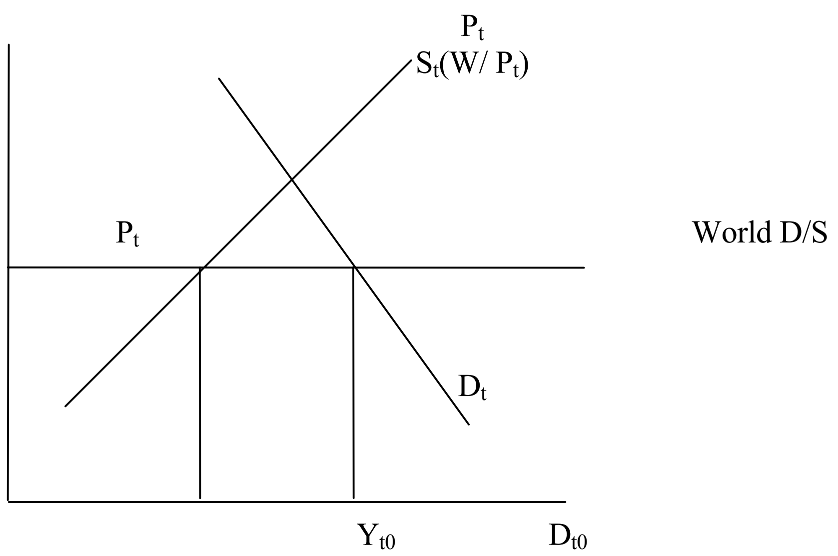
The 'law of one price', operating through goods and services arbitrage, therefore ensures that

(A.1) $$p_t = ep_t^*$$

where e is the price of foreign currency and p_t^* is the world price. Under a fixed exchange rate this means that in this simple stylised model, domestic inflation is determined entirely abroad.[34]

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. This is marked World D/S in Figure A3.1 below at the initial price level p_{t0} (where for simplicity we assume zero world inflation).

Figure A.1: The Traded Goods Sector



[34] For example, in the pre-1979 period when the Irish pound was linked one-for-one with sterling, Irish and UK inflation were indeed equal, and it was widely felt that breaking the link with sterling and tying to the DM would bring Irish inflation down quite rapidly to the much lower German level. However, the single sector SOE model proved to be an inadequate guide to inflation transmission.

Output is determined by firms choosing labour inputs and a level of investment (I_t) that maximises profits π_t:

(A.2) $$\pi_t = p_t Y_t - r^* p_t (K_0 + I + bI^2) - wL_t$$

where $Y_t = F(K_0 + I + L_t)$ is the firm's constant returns to scale production function, the second term is the cost to the firm of borrowing for its capital investments, bI^2 is a capital-adjustment cost term which ensures that firms do not adjust instantaneously to their desired long-run capital stock, as is common in the theory of the firm, and the final term on the right is the wage bill.

Optimisation yields the following labour-demand and investment functions:

(A.3) $$F_{Lt} = w / p_t$$

and

(A.4) $$I_t = I(F_{Kt} / r^*)$$

With constant returns to scale, the marginal products of capital and labour depend only on the capital-labour ratio, which, as (A.3) reveals, is determined by the real product wage.

With capital fixed at a point in time, a disequilibrating increase in real wages will lead to labour-shedding in the short run, and will lead to reduced investment and further labour shedding over time. Higher world interest rates, for a given real wage, will also lead to reduced investment and a fall in employment over time.

This simple model therefore reveals that output is determined by real wages and interest rates. As interest rate effects take time to impact on output, let us concentrate for the moment on the role of real wages in output determination. The supply of output depends on the real wage (w/p_t), which is graphed as S_t in Figure A.1. A rise in wage demands shifts the supply curve to the left, and output is reduced.

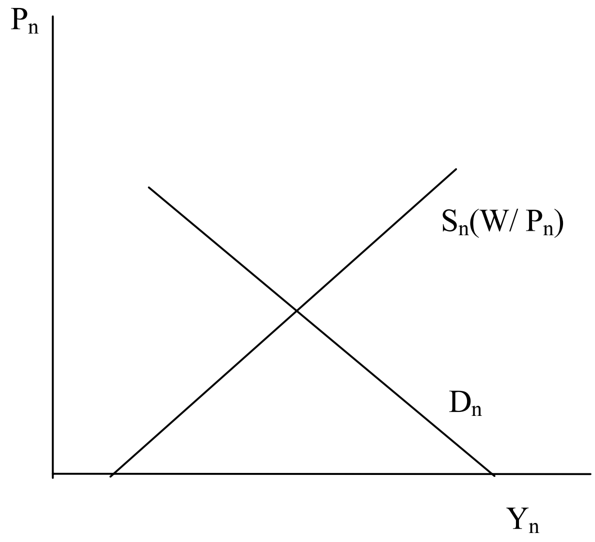
So much for output, employment, inflation and interest rates. What of the trade balance? The trade deficit is determined by the excess of expenditure *(C+I+G)* over income (Y_t). If expenditure is as drawn in Figure A.1, represented by D_t, there is a trade deficit of $D_{t0} - Y_{t0}$

Now consider the impact of fiscal and exchange rate policies in this model. Ignoring taxation (so that it may be realistic to assume that nominal wages are not affected), an increase in government spending raises D_t but leaves Y_t unchanged. Its only effect therefore is to worsen the trade balance. When it comes to be financed by taxation however it is reasonable to suppose that wage demands will rise to some extent in an attempt to compensate, so output and employment will fall. This reveals the extremely non-Keynesian nature of the model.

Now consider a devaluation. The increase in the exchange rate (i.e. the price of foreign currency) raises domestic prices and shifts the world supply/demand line upwards. If domestic wages do not respond then output and employment are increased and the trade deficit reduced. If *real* wages are rigid, on the other hand, so that wage demands rise in line with inflation, the domestic supply curve will shift upwards in the same proportion, and there will be no real effects. The devaluation will have generated inflation without raising employment or output.[35]

To address these criticisms, one can add an extra sector, the non-tradeable (NT) sector, to the one sector model. Output and employment in tradeables continues to be determined as before, while the NT sector operates more like a closed economy model. The interactions between the two sectors prove interesting however. The price of NTs is determined by the interaction of supply and demand for these goods, as in Figure A.2.

Figure A.2: The Non-Traded Goods Sector



Analogous to the situation with tradeables, the supply of non-tradeables depends on real product wages in that sector (w/p_n), while the demand for NTs, D_n, depends on relative prices and on real domestic expenditure as follows:

(A.5) $$D_n = D_n[p_n / p_t; Y_t + (p_n / p_t)Y_n]$$

The first derivative is negative, of course, and the second is positive. As before, the results depend very much on whether nominal wages or real wages are rigid.

Consider nominal wage rigidity first of all. An increase in government spending on non-tradeables raises the demand for non-tradeables and shifts D_n to the right in Figure A.2, raising prices and the output level in that sector. With no effect on wages the output of tradeables is not affected so the policy has unambiguously positive effects on aggregate output and employment, and adverse effects on the price level. The trade balance is also adversely affected, as before. To see this note that, in line with (A.5), expenditure on tradeables is

(A.6) $$D_t = D_t[p_n / p_t; Y_t + (p_n / p_t)Y_n]$$

[35] Kouri (1979) shows that devaluations in Finland typically had real effects lasting several years before the competitiveness gain was lost through increased wage demands.

where both derivatives in this case are positive. The increase in the relative price of NTs and the increase in NT-sector output both raise the demand for tradeables, shifting the D_t line to the right in Figure A.1, which worsens the trade deficit.

A devaluation once again pushes up the world D/S line and expands Y_t. This output effect alongside the increase in the relative price of tradeables expands the demand for non-tradeables, and leads to a knock-on expansion in this sector.[36] If wages do catch up with policy-generated inflation, however, the effects can be substantially different. This case, of *real wage rigidity*, can be written:

(A.7) $$w = \phi(p_n, p_t)$$

where $\Phi()$ is a linearly homogenous function. Now, with no nominal rigidities in the system, a nominal shock such as a devaluation can have no *real* effects. An increase in *e* will simply give rise to equiproportionate increases in p_t, p_n and *w*, and employment and output levels will be unchanged. Even with wage demands linearly homogenous in prices, however, a fiscal shock will still have real effects. We now turn to an analysis of these effects.

With the exchange rate fixed in the SOE model, p_t remains constant, so any increase in p_n gives rise to a less-than-proportionate increase in w (which follows from the linear homogeneity of equation (A.6)). An increase in government spending on non-tradeables in this scenario, then, pushes up D_n and p_n as before. Since w rises less than p_n, the fall in the real product wage stimulates output and employment in the NT sector. The wage shock however gets transmitted to the tradeable goods sector, so w/p_t rises, and Y_t and L_t are reduced.

The T and NT sectors therefore move in opposite directions in response to a government expenditure shock, when real wages are rigid. The impact on aggregate employment, *L*, can be calculated from

(A.8) $$L = L_n(p_n / w) + L_t(p_t / w)$$

and the wage equation (A.7).

The effect of a fiscal expansion is positive, zero or negative, then, depending on whether the following expression is greater than, equal to, or less than one:

(A.9) $$[\varepsilon(L_n; p_n / w) / \varepsilon(L_t; p_t / w)][\varepsilon(w; p_t) / \varepsilon(w; p_n)][L_n / L_t]$$

The functions on the left-hand side are the elasticities of sectoral labour demands and of wage demands. Total employment is therefore more likely to rise in response to increased government on non-tradeables, the greater is the elasticity of labour demand and the initial level of employment in that sector, and the lower the influence of non-tradeable goods prices on the

[36] For example, the devaluation of the Irish pound in 1986, at a time when unemployment was at an all time high, appeared to have had such unambiguously positive effects on output and employment, which were not then inflated away through wage catch-up; Giavazzi and Pagano (1990), Barry (1991). The fact that they were not inflated away, though, could possibly be an effect of the Irish fiscal contraction which began in 1987.

nominal wage, the latter obviously being related to the share of these goods in private consumption. This is a standard condition in the literature (see Barry and Devereux (1995) and the references cited there), and is usually considered to hold.

Adopting the long-run condition that the return to capital be equalised across sectors will of course tie down prices in the SOE, as the following equations reveal:

(A.10)
$$p_n = a_{Ln} w + a_{Kn} r$$
$$p_t = a_{Lt} w + a_{Kt} r$$

since both w and p_t are fixed, yielding two equations in two unknowns, p_n and r. (a_{ij} represents units of factor *i* per unit output of good *j*).

For wage stickiness to be possible as an equilibrium in this model, *r* must be endogenous to the region/SOE (since p_t, w and r cannot all be exogenous); i.e. the stock located there must be related to the gap between regional (or SOE) and national (or international) required rates of return.[37] While it may at first seem implausible that these required rates of return could differ, not allowing them to differ would require that the own price elasticity for capital should be infinite. Bradley and Fitz Gerald (1990) however are able to model Ireland's share of world output as dependent on relative profitability levels, and show that the own price elasticity of capital, when domestic output is allowed to adjust, is of the order of -0.4.

The empirical evidence for Ireland suggests then that the appropriate long-run condition on rates of profitability should be

(A.12)
$$K = K(r - r^*)$$

rather than $r = r^*$, where K is the domestic capital stock and r^* is the international rate of profitability. Combining this with equations (A.10) above then gives us a system of three equations in three unknowns, when wages are rigid, and the model can then generate an equilibrium.

Allowing the return to capital to be determined endogenously in this way, a fiscal contraction in the wage-rigidity case reallocates capital from the NT sector to the T sector; capital-labour ratios remain unchanged in each sector, and the impact on employment then depends on the relative factor intensities of the two sectors (Helpman (1976)).

Besides generating more realistic fiscal-policy effects, one of the other advantages of introducing a non-tradeable goods sector is that deviations from PPP are more easily analysed in this context. Purchasing power parity (PPP) asserts that a relationship such as that depicted in equation (A.1) holds not just for traded-goods prices but also for price levels. This will hold however only if relative prices (i.e. the ratio of non-traded to traded goods prices or *the real exchange rate*) are constant. As noted above, this will apply only if shocks hitting the economy are monetary in nature (since real shocks will change equilibrium relative prices), and even

[37] This is in fact similar to applying an Armington assumption to the financial sector, an assumption which does not of course apply to goods markets in the SOE model.

then, given some short-run nominal rigidities, PPP would only be expected to hold in the long run.[38]

Another advantage of introducing a non-tradeable goods sector is that Keynesian phenomena are also more easily analysed. Given the intense competition assumed to prevail in the international marketplace, as well as the possibility of arbitrage, it is difficult to envisage long-lasting deviations from the law of one price. The possibility of non-tradeable prices remaining at disequilibrium levels for some period of time is less controversial however (Neary (1980)). The requirements for a Keynesian recession are that nominal wages and some output prices be sticky (Neary (1990)).[39] Thus if a fall in demand for non-tradeable output occurs, this sector will contract without any stimulus towards the expansion of the tradeable sector being imparted. Under Keynesian conditions therefore a decline in government spending will have large effects on output and employment whether real or nominal wages are rigid.

Short-run stickiness in the price of non-traded goods means that a devaluation of the nominal exchange rate translates into a real exchange rate depreciation. The resulting fall in the real product wage in the traded-goods sector induces that sector to expand, while the knock-on effects seen in equation (A.7) are likely to cause the other sector to expand also.

Both fiscal and exchange rate policies are therefore likely to have strong positive short-run effects in conditions of Keynesian recession. A similar result applies to monetary policy, even under fixed exchange rates, as will be clear from the discussion above of the monetary approach to the balance of payments. In line with Dornbusch (1976), similar effects will arise under flexible exchange rates, as with sticky nominal wages and non-traded goods prices the real exchange rate depreciates temporarily in response to a monetary expansion.

[38] For example, given the existence of NTs it would have been completely wrong of Irish policy makers in 1979 to expect that simply because Irish inflation closely matched UK inflation in the pre-79 (i.e., pre-EMS) period, it would come quickly down to German levels *regardless of domestic conditions* if the currency were tied to the DM.

[39] Thus Neary writes that 'it is the interaction of such failures (e.g. a sticky price of the non-traded good, or an export sales constraint) with the rigid wage in the labour market which gives rise to Keynesian phenomena'.

Appendix 2: The NDP mechanisms in the Polish HERMIN model

A2.1: Linking the externality mechanisms into the model structure

(i) Output externalities

The output externalities can be viewed as operating directly through the multinational and indigenous firm location and growth process that is so important in the case of the EU periphery and, more recently, in the CEE countries, and draws directly from the extensive literature surveyed in Appendix 3 below. The treatment of the manufacturing sector in HERMIN posits a supply side approach in which the share of the world's output being allocated to, or generated within, a peripheral country or region is determined by measures of domestic and international cost competitiveness (Bradley and Fitz Gerald, 1988).

However, this neglects the fact that many industries will require more than simply an appropriate level of, say, labour costs before they locate in, or grow spontaneously in, the EU periphery. Without an available labour force that is qualified to work in these industries, or without appropriate minimum levels of physical infrastructure, many firms simply may not be able even to consider the periphery as a location for production. Thus, a more realistic framework is one which posits a two stage process in which basic infrastructural and labour force quality dictates the number of industries which could conceivably locate in the periphery, while competitiveness decides how many of the industries which can locate in the periphery actually do locate there.

One simple way of describing this process is to link the growth of infrastructure and the increases in human capital to a modified version of the HERMIN behavioural equation that is used to determine manufacturing sector output (OT). The theory underlying the macroeconomic modelling of a small open economy requires that this equation reflect 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 (MNEs). By contrast, domestic demand should play only a limited role in a purely traded sector, mostly in terms of its impact on the rate of capacity utilisation. However, our classification of the traded sector as being made up of manufacturing is somewhat imperfect in practice, since manufacturing in any but extreme cases includes a large number of sheltered subsectors producing non-traded items. Hence, we would expect domestic demand to play a more substantial role in this sector, possibly also influencing capacity output decisions of firms. We therefore posit a hybrid supply-demand equation of the form:

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

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

To take account of output externalities associated with infrastructure and human capital, the following two terms are added to the above equation:

$$\eta_1 \log(KGINF_t / KGINF_0) + \eta_2 \log(NTRAIN_t / NTRAIN_0)$$

where output in the manufacturing sector (*OT*) is now directly influenced by any increase in the stock of infrastructure and human capital (KGINF and NTRAIN, respectively) over and above a baseline value for these stocks ($KGINF_0$ and $NTRAIN_0$, respectively). Thus, if the stock of infrastructure increases by 1 per cent relative to the baseline stock, output in manufacturing (OT) is boosted by η_1 per cent. If the stock of human capital increases by 1 per cent relative to the baseline stock, output in manufacturing (OT) is boosted by η_2 per cent.[40]

Such a modification attempts to capture the notion that a peripheral region or country can now attract a greater share of mobile investment than it otherwise could in the absence of improved infrastructure and human capital. Another, demand side, way of interpreting this externality could be to assume that the NDP may improve the quality of goods produced domestically and thus improve the demand for goods produced by firms already located in the country, whether foreign or indigenous.

(ii) Factor productivity externalities

A factor productivity externality can be associated with improved supply conditions in the economy brought about as a result of investment in human capital and public infrastructure. These can be incorporated into HERMIN by endogenising the "scale" parameter in the CES production function, 'A', which is now modelled as a function of the stock of public and human capital. Increases in the value of 'A' imply that for a given amount of inputs a higher level of output is produced.

We can illustrate this schematically in terms of the simple production function

$$Q = A * f(L, I)$$

where A is the scale parameter, which can be considered to represent the state of technology, and L and I are the labour and investment inputs, respectively.

Public infrastructural investment will increase the efficiency of the market services sector by cutting down on the costs of producing transport and other communication services, and by opening up greater opportunities for domestic competition to take place in the provision of non-traded goods. Such cost reductions will have a favourable supply-side effect on the internationally exposed manufacturing sector.

The infrastructure factor productivity externality can be incorporated into the production process in manufacturing and market services as follows:

[40] It has to be admitted that we ignore any interactions and complementarities that may exist between physical infrastructure and human capital, since so little is known about this aspect of the CSF.

$$A_t = A_0 \left(KGINF_t \,/\, KGINF_0 \right)^{\eta}$$

where A_0 is the original (i.e., pre-NDP) estimated value of the scale parameter and η is an unknown externality elasticity that can be assigned different numerical values in the empirical model. The variable *KGINF* is the stock of public infrastructure, computed as an accumulation of real infrastructure investments (using the perpetual inventory method with a specified depreciation rate). The baseline stock of infrastructure, $KGINF_0$, is taken as the stock that would have been there in the absence of any NDP infrastructural investments made during the period under consideration.

Similarly, the NDP Social Fund programmes on education and training can be considered to promote the efficiency of the workforce in both manufacturing and services sectors and can give rise to a human capital externality. Incorporation of externality effects associated with the accumulation of human capital is not as straightforward as in the infrastructure case, since there is no readily available measure of the stock of human capital equivalent to the stock of infrastructure. However, one can estimate a measure of the extra number of trainees funded by the NDP schemes (see below for details). Hence, as a first approximation, one can use the inputs into training as a measure of the unknown outputs, although if the training courses are badly designed and poorly executed, the relationship between training and increased human capital will be tenuous.

Suppose we assume that, prior to the implementation of the NDP, the existing number of members of the labour force trained to a specified level, $NTRAIN_0$, is known. If the NDP increases are used to fund an additional number of trainees, giving a total of $NTRAIN_t$ trained members of the labour force in year t, then the scale parameter in the production function can be modified as follows:

$$A_t = A_0 \left(NTRAIN_t \,/\, NTRAIN_0 \right)^{\eta}$$

where A_0 is the original estimated value of the scale parameter. In the empirical model, this externality is incorporated into the treatment of both the manufacturing and service sectors.

A2.2: Modelling NDP physical infrastructure impacts

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

IGVCSF = IGVCSFEC + IGVCSFDP + IGVCSFPR

Inside the HERMIN model, these NDP-related expenditures are converted to real terms (by deflating the nominal expenditures by the investment price) and added to any existing (non-NDP) real infrastructural investment, determining total real investment in infrastructure

[41] For the data on the proposed expenditures in the Polish NDP, aggregated into the appropriate categories, see Table 6.1 in Section 6 above. We stress that these numbers are preliminary and are likely to change as the NDP planning process advances towards completion.

(IGINF). Using the perpetual inventory approach, these investments are accumulated into a notional 'stock' of infrastructure (KGINF):

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

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

$$KGINFR = KGINF / KGINF_0$$

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

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

In the absence of any externality mechanisms, the standard HERMIN model can only effectively calculate the mainly demand (or Keynesian) effects of the NDP infrastructure programmes, the supply effects being only included to the very limited extent that they are captured by induced shifts in relative prices. It is already well known that the policy multipliers are relatively small in the case of Ireland and somewhat larger in the cases of Greece, Portugal and Spain. (ESRI, 1997). However, the HERMIN model permits us to introduce various externality effects to augment the conventional demand-side impacts of the NDP infrastructure programmes in order to capture likely additional supply-side benefits. In each case, the strength of the externality effect is defined as a fraction of the improvement of the stock of infrastructure over and above the baseline (no-NDP) projected level, i.e.,

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

where η is the externality elasticity. The way in which the externality elasticity can be approximately calibrated numerically, drawing on the empirical growth theory research literature, was discussed above (see Bradley, Morgenroth and Untiedt, 2000 for full details and Appendix 3 below for a summary). In all the model-based simulations reported in this report, the externality effects are phased in linearly over a five year period from 2004, reflecting the implementation stages of the NDP 2004-06 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.[42] This phasing will be adjusted when more detailed information becomes available.

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

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[42] Hence, 0.2 of the full externality effect occurs in the year 2004; 0.4 by the year 2005; 0.6 by the year 2006; 0.8 by the year 2007 and the full impact by the year 2008 and onwards.

i. The direct influence on manufacturing output (OT) of improved infrastructure (KGINF), i.e. any rise in the stock of infrastructure relative to the no-NDP baseline (KGINFR) will be reflected in a rise in output.

ii. Total factor productivity (TFP) in the manufacturing and service sectors is increased

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

A2.3: Modelling NDP human resources impacts

The HERMIN model assumes that any expenditure on human resources directly financed by NDP aid subvention from the EU (GTRSFEC) is matched by a domestically financed public expenditure (GTRSFDP). Hence, the total expenditure on human resources (GTRSF) is defined in the model as follows (in current prices):

$$GTRSF = GTRSFEC + GTRSFDP$$

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

Since the full institutional detail of the NDP human resource training and education programmes cannot be handled in a small macroeconomic model like HERMIN, one needs to simplify drastically. Each trainee or participant in a training course is assumed to be paid an average annual income (WTRAIN), taken to be a fraction (0.5) of the average industrial wage (WT). Each instructor is assumed to be paid the average annual wage appropriate to the market service sector (WN). We assume a 75 per cent overhead on total wage costs to take account of buildings, equipment, materials, etc (OVERHD), and a trainee-instructor ratio of 15:1 (TRATIO). Hence, total NDP 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. This formula is actually inverted in the HERMIN model and used to estimate the approximate number of extra trainees that can be funded by the NDP for a given total expenditure GTRSF on human resources, i.e.,

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

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

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

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

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

In order to quantify the increase in the stock of human capital (measured in trainee years), we need to define the initial pre-NDP stock of human capital, $KTRAIN_0$. This is a conceptually difficult challenge, and we are forced to simplify drastically. We base our measure of human capital on the average number of years of formal education and training that the labour force has achieved prior to the NDP. We can cut through the complex details of the education system and stylise is 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

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

The accumulated stock of NDP 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 NDP human resources programmes:

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

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

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

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

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

here η is the externality elasticity. In all the model-based simulations reported below, the externality effects are phased in linearly over a five year period from 1994, reflecting the implementation stages of the NDP programmes and the fact that benefits from improved infrastructure may only be exploited with a lag by the private sector in terms of increased activity.

Two types of externality effects associated with human capital are introduced into the HERMIN model:

i. The <u>direct</u> influence on manufacturing output (OT) of improved human capital, i.e. any rise in the "stock" of human capital relative to the no-NDP baseline (proxied by KTRNR) will be reflected in a rise in output.

ii. <u>Labour embodied</u> technical change in the manufacturing and service sectors is increased, where a given output can now be produced by less workers or where any increased level of sectoral output can become more skill intensive but less employment intensive

A final change made to the HERMIN model to handle the NDP human resources programmes relates to the impact on the rate of unemployment of moving people out of the labour force and into temporary training schemes. 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). For simplicity it is assumed in subsequent analysis of the NDP human resource investment impacts that all 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. This assumption is consistent with the stylised facts of the hysteresis in Irish and Portuguese labour markets (Bradley, Whelan and Wright, 1993;

Modesto and das Neves, 1993). It is implemented in the HERMIN model by defining a 'corrected' measure (URP) of the unemployment rate (UR) for use in the Phillips curve.

Appendix 3: infrastructure, and human capital and growth

A3.1: Introduction

Over the past decade there has been renewed academic interest in the issue of economic growth. The focus of much of this work has been to model more explicitly the factors which impact on a country's growth rate, and in particular how policy can alter that growth rate. This approach stands in contrast to the earlier growth models which explained economic growth simply through technical progress, the sources of which were not explained. In these earlier models, growth was essentially exogenously driven with policy measures changing the transition path but not the long run steady state growth rates of an economy. These models also predicted convergence among economies which, due to diminishing returns to factor inputs, would arise if countries had similar rates of technical progress.

The recent endogenous growth theory has addressed the shortcomings of the earlier pioneering literature. An important feature of the endogenous growth models is the existence of spillovers or externalities which arise from particular investments due to their public good characteristics. These externalities generate additional unintended benefits to the productive capacity of an economy. In contrast to the earlier exogenous growth models, automatic convergence is not predicted by the more recent endogenous growth models. There can be winners and losers.

In particular the endogenous growth literature has investigated how technical progress can be affected directly through investments in research and development (R&D), and this has been incorporated into growth models as the accumulation of knowledge (e.g. Romer, 1986) or improvements in the quality of intermediate inputs (e.g. Aghion and Howitt, 1992, 1998). Here externalities arise when innovations in one firm are adopted elsewhere, i.e., when such innovations have public good qualities. Another line of research has concerned the level of social capital, that is the institutions, government policies and interpersonal relationships that exist in a country (see Zak and Knack, 1998, Hall and Jones, 1999). In this literature social capital affects the development of all other types of capital. Importantly, the new literature has also focused on two aspects which have important implications for the evaluation of the structural funds, namely the role of investments in infrastructure and human capital. Since these are of particular interest they are discussed in detail below.

A3.2: Infrastructure

The effect of public infrastructure in growth models, is typically incorporated as an additional input in the production function (Barro, 1990, Futagami et. al., 1993). Because public infrastructure is a public good, that is, it can be used by many producers (and consumers) at the same time without reducing its usefulness, it gives rise to externalities, which we refer to as output externalities. Thus, if production is characterised by constant returns to scale in the private inputs (labour, capital and intermediate inputs) a doubling of all private inputs will double output, even if the level of infrastructure is held constant, which implies increasing returns in all inputs. This externality is captured by the effect that infrastructure has on the level of output. Another way in which infrastructure can have a beneficial impact is by raising the total factor productivity of all inputs (Hulten and Schwab, 1991), which we refer to as the factor productivity externality. Here infrastructure allow these private factors of production to work more efficiently raising their marginal product. For example in the case of workers, these waste less energy travelling to work if a country has good transport infrastructure and they will thus be less tired from travelling to work and therefore work harder.

While these are the most natural ways of modelling the impact of infrastructure on growth some other approaches have also been used. For example infrastructure impacts on economies by connecting them. Thus, Kelly (1997) argued along Smithian lines that infrastructure allows for an expansion of markets which in turn increases specialisation which improves efficiency and therefore growth. In this model growth is subject to threshold effects, requiring sufficient infrastructure to properly integrate markets which then increases specialisation. Another way in which infrastructure has been incorporated into growth models is to assume that infrastructure reduces the cost of intermediate inputs by fostering specialisation (Bougheas, Demetriades and Mamuneas, 2000). This model yields a non-monotonic relationship between infrastructure and long-run growth, which means that there is an optimal stock of infrastructure beyond which additional investment will be detrimental to growth. Thus, countries with a lower stock of infrastructure will have the highest return to additional infrastructure while those with a stock of infrastructure that is above the growth maximising level will actually grow slower with more infrastructure investment. Another important finding of this model is that infrastructure accumulation is very productive if the tax rate is low and counter productive if the tax rate is too high.

In general it is important to note that while infrastructure has beneficial public good characteristics, it has to be financed through taxes and it is therefore important that the tax revenue is spent in infrastructure that is more productive than any other expenditure that could have been financed by the tax take. This argument has been supported by empirical research, which shows that certain types of infrastructure impact more than others on output. For example Pereira (2000) finds that for the USA, that electricity and gas facilities have the highest return, while conservation structures have the lowest return. He also finds a relatively small impact for roads infrastructure, which might surprise some people but, which accords well with the discussion above. The USA already has a highly developed roads network and is therefore unlikely to benefit much from additional roads.

Not every sector benefits equally from infrastructure. Thus agriculture is often found to have the lowest return to public infrastructure (see Pereira and Roca-Sagales, 2001). Thus, ceteris paribus, a country with a higher proportion of agriculture, will benefit less from infrastructure than one where agriculture is less important. Furthermore, how efficiently a given stock of infrastructure is used also impacts significantly on the effect that infrastructure has as was noted by Hulten, (1996). He shows that, a one percent increase in the efficiency of use has a significantly larger impact than an equivalent increase in the stock of infrastructure.

As was mentioned above in Section 3.3, the elasticities used to incorporate the externality effects of infrastructure are taken from existing studies, which are reviewed in this section. Fortunately, a large body of literature exists that has estimated these effects, focusing largely on the estimation of the rate of return to infrastructure. This is inferred from the output elasticity of infrastructure, and the latter is estimated under the assumption that infrastructure enters the production function as a public intermediate input. An alternative approach involves the estimation of a cost function and associated factor demand functions which yields shadow values for infrastructure. Here particular emphasis is placed on studies covering the countries which contain regions that qualify for Objective 1 Structural Funds.

(i) Germany

Output elasticities for East Germany have so far not been published. However a number of studies for West Germany have been completed. Using state level data, (Seitz, 1995a) finds output elasticites with respect to infrastructure to range between 0.06 and 0.19. Stephan (2001) using city level data finds these to range between 0.11 and 0.74 and a separate study by Kemmerling and Stephan (2001) finds this elasticity to be 0.17. The alternative approach of using cost functions has been utilised by Conrad and Seitz (. 1992 and1994), Seitz and Licht (1995) Seitz, (1993, 1994, 1995b). These studies find the cost elasticity with respect infrastructure to lie between 0.02 and –0.34.

(ii) Spain

There have been a number of studies on the impact of infrastructure in Spain. At the national level there have been two studies. The first one by Bajo-Rubio and Sosvilla-Rivero, (1993) found output elasticities with respect to public capital to range between 0.16 to 019. The second study by Pereira and Roca-Sagales (2001) found these elasticites to lie between –0.39 to 1.23 where these values are long run accumulated elasticities and where the negative value refers to the agricultural sector and the highest value refers to the construction sector. However over all sectors the elasticty was found to be 0.52. At the regional level there have been a nuymber of studies for Spain. Canalata, Arzoz and Garate, 1998) found the elasticites to lie between 0.03 to 0.15, (Cutanda and Paricio, 1994) 0.37 to 0.62, (De la Fuente and Vives, 1995) 0.21, Flores de Frutos et.al., (1998) 0.21, and Mas et.al. (1996) 0.07-0.08. Finally Moreno, Lopez-Bazo and Artis (2002) utilising a cost function found the long run cost elasticity with respect to infrastructure to be –0.02.

(iii) Greece

For Greece, Mamatzakis (1998a) finds an output elasticity with respect to infrastructure of 0.27, and in a further study (Mamatzakis, 1998b) he estimates the cost elastity with respect to public infrastructure to lie between 0.54 and –0.72, with only a positive elasticity being found in only one case (industry). Rovolis and Spence (1999) find output elasticities that range from 0.25 to 0.74 for manufacturing. Dalmagas (1995), on the other hand, obtains rather mixed results using the production function, cost function and profit function approaches. Specifically he finds a negative output elasticity with respect to infrastructure (-1.24) implying that additional infrastructure will reduce output, while the cost and profit function approaches indicate significant gains from additional infrastructure, by lowering costs by 2.35% in response to a 1% increase in infrastructure or increasing profits by 1.06% in response to this 1% increase in infrastructure. Clearly these estimates are somewhat extreme, especially in the light of the findings of the other studies.

(iv) Ireland, Italy and Portugal

The only published study for Ireland is that by Kavanagh (1997) who uses the production function approach in conjunction with modern time series methods. She finds an output elasticity of 0.14, which however was not statistically significantly different from zero. Denny and Guiomard (1997) on the other hand find unrealistically high output elasticities which range from 0.93 to 6.3! For Italy Picci (1999) uses different measures of infrastructure at the regional level. For all infrastructure he finds output eleasticites in the range of 0.07 to 0.36 while that for the core infrastructure averages 0.5. For the Mezzogiorno the elasticity of output with respect to all infrastructure is 0.54 for the period 1970-1982 and 1.1 for the period 1983-1995, while for the same periods those for core infrastructure were 0.49 to 0.80 respectively. For Portugal results have recently been published (Ligthart, 2000). The results from this study imply that the output elasticity of public capital lies in the range of 0.2 to 0.39 and that changes in public capital induce output changes.

In summary, the production function studies suggest that the elasticity of output with respect to infrastructure is likely to lie in the range 0.1 to 0.7, while cost function studies find somewhat smaller cost elasticities of between -0.05 and -0.2.

A3.3: Human capital

The role of human capital is a vital field of research since human capital can be viewed as an essential prerequisite to the adoption of the types of change induced by globalisation and new technologies. Human capital has also been incorporated into endogenous growth models in order to explain sustained long-run growth (see Lucas, 1988)[43]. Again, human capital enhances the productivity of all private factors. A number of issues and challenges emerge from the literature and will be reviewed[44].

The first issue concerns the different mechanisms for human capital development that have been put forward in the literature. Thus, human capital can be acquired through education, learning-by-doing or be passed on between generations. However, a crucial distinction has been made between models where human capital is needed for R&D purposes (see Aghion and Howitt, 1992) and models where human capital enters directly in the production function (Lucas, 1988). The former approach implies that growth is driven by the stock of human capital whereas the latter implies that growth is driven by the process of accumulation of human capital (see Aghion and Howitt, 1998). Both approaches have some drawbacks. The Lucas approach assumes that the marginal product of human capital remains positive regardless of the state of technology which is unrealistic. On the other hand the Aghion and Howitt approach incorporates scale effects that suggest that large countries should grow faster since other things being equal large countries possess a larger stock of human capital which is not supported by the data (see Cannon, 2000).

An important issue in this research is the fact that the empirical evidence at the macro level is not conclusive regarding the growth effects of human capital. Thus, while some studies (e.g. Benhabib and Spiegel, 1994) find little evidence that human capital growth positively affects output growth, other studies (e.g. Temple, 1999 and Bassanini and Scarpetta, 2001) do find a correlation between the two. At least to some extent these conflicting results can be attributed to the difficulty in measuring human capital (Hanushek and Kimko, 2000).

In contrast to the empirical macro literature, there is a broad consensus in the empirical micro economic literature that education has a positive and significant effect on individual earnings (see Ashenfelter, Harmon & Oosterbeek, 1999). This further highlights the challenge to reconcile and integrate the micro- and macroeconomic approaches. Thus, theoretical and

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[43] An augmented Solow model that includes human capital was put forward by Mankiw et. al. (1992). However, this model does not provide a mechanism for endogenously driven growth, and therefore still relies on exogenous technical progress as a source of sustained growth.

[44] Other reviews of this literature can be found in Temple (1999), OECD (2001) and Sianesi and Van Reenen (2002).

empirical investigations into the economy-wide impact of human capital on aggregate output and growth still continue and no firm consensus has yet emerged.

As was mentioned above, one of the main research challenges is the definition of the human capital variable used in empirical investigations. Thus, some authors use the enrolment rate, i.e. the percentage of the working population of school age which is in second level education at a point in time (Mankiw, Romer and Weil, 1992). However this does not measure the stock of human capital in an economy at that point in time, but rather measures the future additions to that stock. An alternative measure is the average years of schooling of the labour force, which is a measure of the stock of human capital (Benhabib and Spiegel, 1994). However even this measure is far from perfect, since it does not account for school quality, which some researchers measure using the amount spent on education. Of course higher expenditure does not automatically result in better quality of education or training, particularly if a substantial proportion of the funds are used in an inefficient way. It is beyond the scope of this report to settle this debate and we therefore simply review some of the interesting results which have been obtained.

In an influential paper, Mankiw, Romer and Weil (1992), using a cross country data set, found that the output elasticity with respect to human capital as measured by the second-level school enrolment rates is in the region of 0.3. This work has been extended by Nonneman and Vanhoudt (1996), who find that elasticity to be somewhat smaller at 0.15. Further corroborating evidence for this result has been put forward by Demetriades, Arestis and Kelly (1998), using mean years of schooling as a proxy for human capital, who found the output elasticity to be 0.37. Griliches and Regev (1995) use a labour quality index which is based on the mix of academic qualifications in the labour force in a study of firm productivity in Israeli industry, and find the elasticity of output per worker with respect to labour quality to fall in the range between 0.14 and 0.74.

The above papers all use the level of the human capital proxy in regressions with the level of output as the dependent variable. This suggests that growth rates should be related positively to rate of change of these human capital proxy measures. However, there is evidence which suggests that this may not be so. Benhabib and Spiegel (1994), again in a cross country setting, find that the change in educational attainment affects growth negatively though not statistically significantly. Furthermore they find weak evidence for a positive impact of the level of human capital on the growth rate of output. Finally they find that the level of human capital has a positive and often significant effect on investment, which suggests that human capital affects the rate of technological innovation as well as the speed of that adoption of new technologies.

Further evidence supporting the link between the level of human capital and output growth is provided by Barro (1991), using enrolment rates, and Barro and Sala-I-Martin (1995), using second and higher level educational attainment. However, the latter only find male second and higher level educational attainment has a statistically significant positive impact on growth, while the same variables for females has a negative though not statistically significant effect on growth.

Our brief review of the academic literature indicates that, on balance, human capital is likely to have a positive impact on output and that the output elasticity probably lies in the range of 0.15 to 0.4. However there is obviously an urgent need for further work in this area. In particular the existing literature has yet to address the issue of spillovers of human capital as there have been few attempts to estimate the productivity effect of the presence of a highly educated worker on a worker with lower human capital (a notable exception is Acemoglu and Angrist, 2000).

A3.4: References

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