THE MACRO IMPACTS OF SPD 2004-2006 ON THE ESTONIAN ECONOMY: A MID-TERM ASSESSMENT

prepared by

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Summary of main SPD impacts

In this report we examine the likely impacts of the Estonian SPD 2004-2006 in two different ways. First, we quantify the likely impacts of the "planned" SPD investment programmes designed for implementation for the three years 2004-2006. Second, we quantify the likely impacts of the "actual" investment expenditures implemented for the two years 2004-2005 inclusive.

Since we do not yet have the actual investment expenditures for the current year, 2006, we compare the likely impacts in the two years 2004 and 2005 in both cases. The SPD financial data indicate that only a small proportion of the planned expenditures were actually carried out by the end of 2005. Hence, we expect that the impacts of the planned SPD will greatly exceed that impacts of the actual SPD.

The most common indicators used to evaluate SPD impacts are the level and growth rates of GDP and the level of employment and unemployment. The following two tables summarize our main results.

Planned SPD 2004-2006 Impacts

Date	GDPM /p	GDPMDOT /d	L /d	UR /d
2003	0.00	0.00	0.00	0.00
2004	1.36	1.47	6.23	-0.94
2005	1.91	0.57	8.12	-1.22
2006	2.49	0.59	9.96	-1.50
2007	0.50	-2.04	0.46	-0.07
2008	0.33	-0.17	-0.12	0.02
2009	0.19	-0.15	-0.59	0.09
2010	0.18	0.00	-0.55	0.08

Actual SPD 2004-2005 Impacts

Date	GDPM /p	GDPMDOT /d	L /d	UR /d
2003	0.00	0.00	0.00	0.00
2004	0.22	0.23	1.06	-0.16
2005	0.89	0.71	4.02	-0.60
2006	0.13	-0.79	0.20	-0.03
2007	0.08	-0.05	0.08	-0.01
2008	0.03	-0.05	-0.13	0.02
2009	0.03	0.00	-0.12	0.02
2010	0.03	0.00	-0.12	0.02

In these summary tables, the notation is as follows:

i. ***GDPM/p*** indicates the increase in the level of GDP due to the SPD investment programmes, compared to the no-SPD baseline scenario. Since population is roughly constant in the short to medium term, this is also approximately the same as the increase in the level of GDP per capita.

ii. ***GDPMDOT/d*** indicates the difference between the "with-SPD" growth rate of GDP and the "baseline" GDP growth rate.

iii. ***L/d*** indicates the difference between the "with-SPD" total numbers employed (measured in thousands) and the "baseline" level of employment.

iv. Finally, ***UR/d*** indicates the difference between the "with-SPD" total rate of unemployment (expressed as a percent of the labour force) and the "baseline" rate of unemployment.

It is only meaningful to compare these two cases for the years 2004 and 2005. By the year 2005, our HERMIN-based estimates suggest that the actual SPD programmes raised the GDP growth rate by about 0.2 percentage points in 2004 and 0.7 percentage points in 2005. The planned SPD, on the other hand, raised the GDP growth rate by 1.5 percentage points in 2004, and by .6 percentage points in 2005. In the "actual" SPD, the level of expenditure accelerated between 2004 and 2005, which explains why the impact on GDP growth also increased. In the "planned" SPD, the rate of expenditure was steady, with one third used each year. So, the impact on the growth rate peaked in the first year, and was modest afterwards.

The simulation results also suggest that the "actual" SPD lowered the rate of unemployment by 0.2 percentage points in 2004 and by 0.6 percentage points in 2005. The "planned" SPD would have lowered the rate of unemployment by 0.9 percentage points in 2004 and by 1.2 percentage points in 2005.

These summary results have to be interpreted with great care. In the remainder of the report we explain how they were derived, and examine the sensitivity to a series of key assumptions.

[1] Introduction

The purpose of the study is to carry out an initial analysis of the impact of SPD 2004-2006 for Estonia. This SPD has now run for two of its three year duration and interim data are available. The following impact analysis will consist of an evaluation of the complete original planned SPD expenditure pattern for the three years 2004-2006, inclusive), and a separate evaluation of the actual SPD expenditures incurred over the two years 2004-2005.

The main macroeconomic variables upon which impacts are to be assessed include: GDP, total employment, labour productivity, and unemployment.[1] In addition, a range of other relevant variables derived from the HERMIN model structure (see Section 3) are reported, in order to build up a comprehensive assessment of SPD impacts.

An important element of the study was that a clear distinction is made between the short-run demand effects of the SPD policy expenditures, i.e., the effects generated during the implementation of the actual policy programmes, and the longer-run supply-side effects. These supply-side impacts only become manifest mainly after the investment expenditures have ceased after the completion of the policy programmes, and when beneficial effects flow from improved stocks of physical infrastructure, human capital and productive capacity. To capture such a distinction, it is necessary to present model simulation results for some years into the future, both in terms of intermediary impacts and in terms of the cumulative total impacts. Since SPD 2004-2006 is of relatively short duration, and the investments are modest (at least compared to the planned investment expenditures of the next SPD 2007-2013), we run the impact simulations only out to the year 2010.

The rest of the report is organised as follows. In section 2 we present a summary discussion of the proposals for the Estonian SPD 2004-2006 expenditure data projections recently made available to us..

In section 3 we provide a brief overview of the structure and properties of the four-sector HERMIN model for Estonia that was recently revised and updated (Bradley, 2006), and which is described in full detail in Bradley, Kangur and Kearney, 2001.[2] The purpose of this section is to alert the reader to some of the more important properties of the HERMIN models insofar as they influence national Structural Fund impacts.

In section 4 we provide a short description of the policy modelling methodology used to evaluate the impacts of the SPD 2004-2006. This approach draws on the previous research on the impacts of national NDP programmes and uses the HERMIN model framework for Estonia to handle explicitly the way in which the funds are designed to alter the structure and performance of economy.

[1] Where labour markets are closed, and labour supply inelastic, the impact on unemployment is simply the negative of the impact on employment.

[2] Since the newly implemented ten-sector model (HEN) is not as robust as the well established four-sector HE4 model, we use only the HE4 model.

In section 5 we present an initial analysis of the impacts of the SPD planned for the period 2004-2006 based on an approximation with respect to funding allocations to the main economic categories (i.e., physical infrastructure, human resource and direct aid to the productive sectors) as well as a central assumption of specific values for the important "externality" elasticities through which the longer term policy impacts occur. These assumptions are selected to represent the most likely findings from the international literature, and are designed to capture the supply-side impacts of investment programmes that are designed and implemented in a small open economies like Estonia.

In section 6 we present a sensitivity analysis with respect to the important "externality" elasticities that determine the long-run impacts.

Section 7 concludes, and summarises the main findings. There is a bibliography of literature sources related to the topics treated in the report.

[2] Data for the Estonian SPD 2004-2006 analysis

2.1: Allocation of EC funding for 2004-2006

To carry out the ex-ante analysis of the impacts of SPD 2004-2006 for Estonia, the following basic information is needed:

i. The total projected level of cash input by the European Commission over the full three years, together with the domestic public co-finance ratio; and

ii. The composition of this input between the three main investment categories, i.e., physical infrastructure, human resources and direct aid to the non-agricultural productive sectors (i.e., manufacturing and market services).

The data provided by the Estonian authorities in their planning for the SPD includes a financial table that identifies the main priorities and some sub-components within each priority. This financial table is reproduced in Table 2.1 below. Note that it gives details of the total expenditure, plus information on the planned annual allocations to each of the individual years.

The allocations of the funding from administrative Priorities to economic categories was arrived at by classifying the expenditures according to the indicated priority and sub-priority, as illustrated in Table 2.2 below. Our allocations are fairly simple.

a) All of *Priority 1* (Human Resource Development) and Priority 5 (Technical Assistance) were combined to form an aggregate Human Resource allocation.

b) *Priority 4* is clearly identified as Physical Infrastructure.

c) *Priorities 2 and 3* form the aggregate Direct Aid to Productive Sectors. These were allocated to the three HERMIN (HE4) private sectors as follows: *Priority 3* was allocated to Agriculture; 80 per cent of *Priority 2* was allocated to Manufacturing; The remaining 20 per cent of *Priority 2* was allocated to Market Services.

Note that we ignore all private funding. In effect, the impacts of private funding are already included in the responses of the model and to insert them along with the domestic public finance runs the risk of double counting.

Table 2.1: Financial table for the planned Estonian SPD 2004-2006

		Total	EC	Domestic Public	Domestic Private
Total Priority 1	HUMAN RESOURCE DEVELOPMENT	99,290,890	76,120,100	23,170,790	0
	2004	24,174,376	18,532,978	5,641,398	0
	2005	32,640,916	25,023,744	7,617,172	0
	2006	42,475,598	32,563,378	9,912,220	0
Total Priority 2	COMPETITIVENESS OF ENTERPRISES	97,583,884	73,187,913	24,395,971	0
	2004	23,758,748	17,819,061	5,939,687	0
	2005	32,079,727	24,059,795	8,019,932	0
	2006	41,745,409	31,309,057	10,436,352	0
Total Priority 3	AGRICULTURE, FISHERIES AND RURAL DEVELOPMENT	109,526,614	69,267,700	27,898,914	12,360,000
	2004	29,750,913	17,144,363	6,994,550	5,612,000
	2005	34,994,271	22,630,983	9,109,288	3,254,000
	2006	44,781,431	29,492,354	11,795,077	3,494,000
Total Priority 4	INFRASTRUCTURE AND LOCAL DEVELOPMENT	181,872,064	138,150,693	43,721,371	0
	2004	43,923,080	33,364,134	10,558,946	0
	2005	60,449,772	45,549,702	14,900,070	0
	2006	77,983,897	59,236,857	18,747,040	0
Total Priority 5	TECHNICAL ASSISTANCE	19,516,061	14,637,046	4,879,015	0
	2004	4,751,576	3,563,682	1,187,894	0
	2005	6,415,709	4,811,782	1,603,927	0
	2006	8,348,776	6,261,582	2,087,194	0
	SPD 2004-06 total	507,789,514	371,363,452	124,066,062	12,360,000
	2004	126,358,693	90,424,218	30,322,475	5,612,000
	2005	166,580,396	122,076,006	41,250,390	3,254,000
	2006	215,335,111	158,863,228	52,977,883	3,494,000

Year	RIGVCSF	RGTRSF	RTRIT	RTRIN	RDCOFIN	Total Aid to Prod Sect
Total	35.81642767	23.3968894	37.69345734	9.423364334	24.4325766	207,110,498
2004	34.76063178	22.89193669	35.52068551	8.880171377	23.99714201	53,509,661
2005	36.28864707	23.44611127	38.26189338	9.565473345	24.76305195	67,073,998
2006	36.21513307	23.60245562	38.59649468	9.649123671	24.60252894	86,526,840

Table 2.2: Actual allocations for 2004 and 2005 within the Estonian SPD 2004-2006

as of 31.Dec. 2005

Funds	SPD measure #	Name of Measure/Priority	2004 EU financing in EUR	2004 domestic public financing in EUR	2005 EU financing in EUR	2005 domestic public financing in EUR
	Total Priority 1	HUMAN RESOURCE DEVELOPMENT	32,209	10,077	7,192,349	1,948,917
	Total Priority 2	COMPETITIVENESS OF ENTERPRISES	1,965,192	655,064	7,403,952	2,467,984
	Total Priority 3	AGRICULTURE, FISHERIES AND RURAL DEVELOPMENT	7,712,012	3,335,585	18,744,026	8,118,968
	Total Priority 4	INFRASTRUCTURE AND LOCAL DEVELOPMENT	4,758,832	1,549,531	24,275,496	7,515,927
	Total Priority 5	TECHINICAL ASSISTANCE	940,183	313,394	3,081,501	1,027,167
	SPD 2004-06 total		15,408,428	5,863,652	60,697,323	21,078,963

	RIGVCSF	RGTRSF	RTRIT	RTRIN	RDCOFIN	Total Aid to Prod Sector
2004	29.6556002	6.091849034	15.3367526	3.834188149	27.5650148	13,667,853
2005	38.87609047	16.20265957	21.49874413	5.374686033	25.7763759	36,734,930

In Table 2.3(a) and (b) below we show the results of aggregating the financial sums under the main and sub-priorities shown in the Financial Table, into the three economic categories: physical infrastructure, human resources and direct aid to the productive sectors. The three "shares" sum to unity and exhaust all the funding.

Table 2.3(a): Average planned allocations of SPD expenditures (2004-06)

Economic category	Percentage allocation	Notation used in HERMIN
Physical infrastructure	35.82	RIGVCSF
Human resources	23.40	RGTRSF
Aid to production sectors	40.78	RTRI
Total allocation	100.00	

Table 2.3(b): Average actual allocations of SPD expenditures (2004-05)

Economic category	Percentage allocation	Notation used in HERMIN
Physical infrastructure		
2004	29.66	RIGVCSF
2005	38.88	
Human resources		
2004	6.09	RGTRSF
2005	16.20	
Aid to production sectors		
2004	64.25	RTRI
2005	44.92	
Total allocation	100.00	

2.2 The analytical treatment of funding allocations

2.2.1 Introduction

The data in the preliminary financial table are in euro, in prices of the year 2004. We designate the total EU contribution as GECSFEC_RE, and this amounts to the sum of 371.363 million euro in total for the three years 2004-2006.[3]

The constant 2004 price data GECSFEC_RE can converted to current prices (GECSFEC_E) by assuming a fixed inflation rate per year from 2004 until 2006.[4] These data are then converted into local currency, using a rate of 15.6466 EK per euro.

The domestic co-finance is derived from the SPD data using the allocations by the EC and the domestic public sector. In the case of the planned SPD 2004-06, the average domestic co-finance ratio is 24.43 per cent. The DP percentage is designated as RDCOFIN ("Rate of Domestic CO-FINance") in the formulae below. In the case of the actual SPD 2004-05

[3] The notation used in HERMIN for Structural and Cohesion-type interventions is based on the older pre-2004 CSF notation. So, GECSFEC_RE indicates public expenditure (GE) on Community Support Framework interventions (CSF), for the EC contribution (EC). The notation "RE" indicates that the expenditure is in real euro.

[4] It might be considered desirable to "inflate" the 2004 planned sums. A facility for doing this is incorporated into the HE4 model. But in light of the short time scale, we set the SPD inflation rate to zero, i.e., real and nominal SPD financial sums are the same.

expenditures, the values taken by RDCOFIN are 27.57 (2004) and 25.78 (2005), respectively.[5]

The total (EC+DP) expenditure is then split between the three main economic categories (physical infrastructure, human resources and direct aid to the non-agricultural productive sectors). The national shares used were those derived above: 70.5 per cent to physical infrastructure, 13 per cent to human resources and 16.5 per cent to direct aid to firms.

The further allocation of the Direct Aid to Productive Sectors (as between manufacturing, market services and agriculture) is carried out using shares. In the case of Priority 2, it was assumed that 80 per cent was allocated to manufacturing and 20 per cent to market services.

2.2.2 Description in terms of analytic HERMIN model formulae

The EC total expenditure contribution for the years 2004-2006 is given in real 2004 euro as a datum (GECSFEC_RE). The constant price data could be inflated to current prices (GECSFEC_E) by applying an inflation rate from 2005 to 2006, after which the funding is assumed to cease abruptly. We set this rate at zero.

$$GECSFEC\_E_{t+2} = GECSFEC\_RE_{t+2} * 1.00^{**(t-1)}$$

where t=1 in the year 2005.[6]

This is converted to local currency (GECSFEC) using the exchange rate (e.g., EEKEUR (the number of units of Estonian currency per euro).

$$GECSFEC = GECSFEC\_E * EEKEUR$$

The implied domestic (DP) co-finance contribution (GECSFDP) is derived by using a domestic co-finance ratio (RDCOFIN), expressed as the ratio of domestic public to total (EC and domestic public) expenditure.

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

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

$$GECSF = GECSFEC + GECSFDP$$

This total is then disaggregated into the three main economic categories.

i. Physical infrastructure (IGVCSF**)

ii. Human Resources (GTRSF**), and

iii. Direct Aid to the Productive Sector (TRI**),

[5] RDCOFIN is defined as the domestic public finance divided

[6] This somewhat complex formula takes account of the fact that the *SPD* expenditures are fixed in the year 2004 by the Commission, and expressed in constant 2004 prices. Hence, if a notional inflation rate of Z per cent per year from 2004 is assumed, the constant 2004 price expenditure (X) for the year 2006 (the last year of the SPD programme) will become $X * 1.0Z^3$.

where ** indicates a further breakdown into an EC (Community) or DP (Domestic Public) contribution.[7]

The percentage share going to physical infrastructure (IGVCSF**) is defined as RIGVCSF; and the share going to human resources (GTRSF**) is defined as RGTRSF. For simplicity, it is assumed that the two shares (RIGVCSF and RGTRSF) apply both to the EC and the domestically co-financed components. The residual goes to direct aid to the productive sector (TRI**).

Physical infrastructure:

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

Human resources:

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

Direct aid to the productive sectors:

$$\text{TRIEC} = \text{GECSFEC} - (\text{IGVCSFEC}+\text{GTRSFEC})$$
$$\text{TRIDP} = \text{GECSFDP} - (\text{IGVCSFDP}+\text{GTRSFDP})$$

Direct aid to the productive sectors (TRI**) is further disaggregated into its three sectoral allocations (manufacturing (T), market services (N) and Agriculture (A)).[8]

Manufacturing (percentage share = RTRIT):

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

Market Services (percentage share = RTRIN):

$$\text{TRINEC} = (\text{RTRIN}/100) * \text{TRIEC}$$
$$\text{TRINDP} = (\text{RTRIN}/100) * \text{TRIDP}$$

Agriculture (residual):

$$\text{TRIAEC} = \text{TRIEC} - (\text{TRITEC}+\text{TRINEC})$$
$$\text{TRIADP} = \text{TRIDP} - (\text{TRITDP}+\text{TRINDP})$$

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[7] The notation used for the three main economic categories is as follows: IGV indicates public infrastructure investment; GTRSF indicates public sector transfers on ESF (Social Fund) activities; TRI indicates transfers to industrial (and service) sectors.
[8] The sectoral notation T in HERMIN indicates the mainly Traded manufacturing sector. The notation N indicates the mainly Non-traded market service sectors. The two remaining sectors of the four-sector HERMIN model are Agriculture (A) and government services (G).

The above approach was adopted so that one could start with any given total allocation of EU funding to the Estonian SPD, and could add in the domestic co-funding, as well as allocate this funding over the main economic categories in a simple fashion depending on a range of four pre-set parameters (i.e., RDCOFIN, RIGVCSF, RGTRSF and RTRIT).

[3] The macro-sectoral structure of HERMIN models

3.1: The structure of the HERMIN model

In this section we give a brief overview of the structure of the Estonian HE4 model. A full description in available in Bradley, Kangur and Kearney, 2001 and Bradley, 2006.

Since the model is constructed in order to analyse medium-term policy impacts, basically there are three requirements which it must satisfy:

(i) It must be disaggregated into a small number of important sectors which allows one at least to identify and treat the key sectoral shifts in the economy over the years of development.

(ii) It must specify the mechanisms through which a "cohesion-type" economy is connected to its external world. The external world as far as Estonia is concerned includes all its main trading partners. The world economy has very important direct and indirect factors influencing the economic growth and convergence of the Estonian economy, through trade of goods and services, inflation transmission, population emigration and inward foreign direct investment.

(iii) It must recognise that a possible conflict may exist between actual situation in the region, as captured in a HERMIN model calibrated with the use of historical data, and the desired situation towards which the regional economy is evolving in an external economic environment dominated by EMU and the Single European Market.

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

a) The degree of economic openness of the economy, exposure to external and 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. Here, the term "traded" refers to sales outside the national economy, and "non-traded" to sales that take place almost entirely inside the boundaries of the state;
c) The mechanisms of wage and price determination, distinguishing between local and international aspects;
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 deficits at the regional level, as well as the interactions between the public and private sector trade-offs in public policies.

To satisfy these requirements, the basic HERMIN framework has four sectors: manufacturing (a mainly externally traded sector), market services (a mainly local or non-traded sector), agriculture and government (or non-market) services. Given the data restrictions that often face modellers in cohesion and transition economies, this is as close an empirical representation of the traded/non-traded disaggregation as we are likely to be able to implement in practice.

Although agriculture also has important traded elements, its underlying characteristics demand special treatment. Similarly, the government (or non-market) sector is non-traded, but is best formulated in a way that recognises that it is mainly driven by policy instruments that are available – to some extent, at least – to policy makers.[9]

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

Conventional demand (or Keynesian) mechanisms are at the core of any HERMIN model. Expenditure and income distribution sub-components generate the standard income-expenditure "multiplier" mechanisms. But the model also has neoclassical features. 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.

From Figure 3.2 we see that the model handles the national accounts' use of three complementary ways of measuring GDP: output, expenditure and 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), and the net trade balance (NTS).[10] 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 regional accounts, but have important consequences for the behaviour of the model as well.

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

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

Figure 3.1: The HERMIN Model Schema

Supply aspects

Manufacturing Sector (mainly tradable goods)

Output $= f_1$*(ExternalDemand, Local 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 $= f_4$*(National Price)*
Wage Rate $= f_{51}$*(Output Price, Tax Wedge, Unemployment, Productivity)*
Competitiveness = Local/International unit labour costs

Market Service Sector (mainly non-tradable)

Output $= f_6$*(Local Demand, Real Unit Labour Costs, t)*
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 $= f_{11}$*(RelativeLocal/International expected wage)*

Demand (absorption) aspects

Household Consumption $= f_{12}$*(Personal Disposable Income)*
Public Consumption = Public Sector Wage Bill + Non-wage Expenditure
Local Demand = Private and Public Consumption + Investment
Net Trade Surplus = Total Output - Local Demand
Expenditure Prices $= f_{13}$*(Output prices, Import prices, Indirect tax rates))*

Income distribution aspects

Expenditure prices $= f_{13}$*(National Expenditure Prices)*
Income = Total Output
Personal Disposable Income = Income + Transfers - Direct Taxes
Current Account = Net Trade Surplus + Net Factor Income From Abroad
*Public Sector Balance = Public Expenditure - Tax Rate * Tax Base*

Key Exogenous Variables
External: National and World output and prices; exchange rates; interest rates;
*Domestic:*Local public expenditure; tax rates.

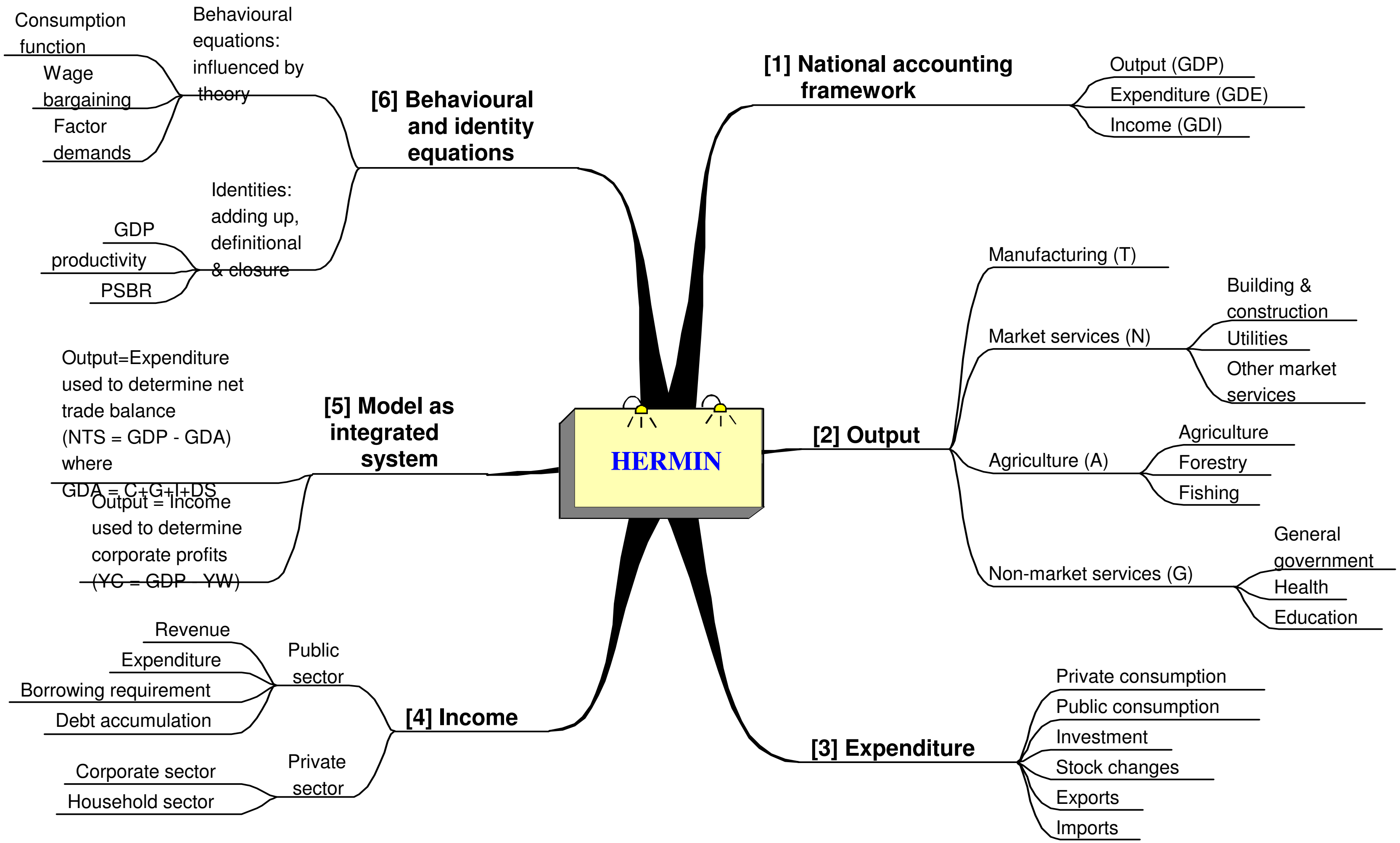

Figure 3.2: Schematic outline of the HERMIN modelling approach

3.2 The supply side of the HERMIN model

(i) Output determination

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

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

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

A fairly simple form of the market service sector output equation (ON) is specified in HERMIN:

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

where FDON is a measure of domestic demand.[11]. Output in agriculture is modelled very simply as an inverted labour productivity equation;

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

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

(ii) Factor demands

Macro models usually feature production functions of the general form:

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

(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 external and local demand, together with price and cost

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[11] Logically, world activity should have no role in determining non-traded output. However, in certain economies (such as Ireland, Estonia, Latvia and Greece), some service activities that are traded (e.g., transit trade, tourism, financial services, etc.).

competitiveness terms. Having determined output in this way, the role of the production function is to constrain the determination of factor demands in the process of cost minimisation that is assumed. Hence, given *Q* (determined as above in a hybrid supply-demand relationship), and given (exogenous) relative factor prices, the factor inputs, *L* and *K*, are determined by the production function constraint. Hence, the production function operates in the model as a technology constraint and is only indirectly involved in the determination of output. It is partially through these interrelated factor demands that the longer run efficiency enhancing effects of policy and other shocks like the EU Single Market and the Structural Funds are believed to operate.

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

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

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

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 highly non-linear joint factor demand equation system of the schematic form:

(3.6a) $$K = g_1\left(Q, \frac{r}{w}\right)$$

(3.6b) $$L = g_2\left(Q, \frac{r}{w}\right)$$

where *w* and *r* are the cost of labour and capital, respectively.[12]

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.

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

(a) First, output in the traded sector (OT) is driven by external demand (OW) and local 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 local 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 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 HEMIN, but can always be extended in later versions as satellite models, where the institutional aspects of agriculture are fully included. GDP in agriculture is modelled as an inverted productivity relationship (see above). Labour inputs into agriculture are modelled as a (usually declining) time trend, and not as part of a neo-classical optimising system, as in manufacturing and market services. Investment in agriculture is modelled as a (usually positive) trended investment/output ratio.

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

(iii) Sectoral wage determination

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

(3.7a) WNDOT = WTDOT + stochastic error

(3.7b) WADOT = WTDOT + stochastic error

(3.7c) WGDOT = WTDOT + stochastic error

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

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

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

b) *The tax wedge*: This wedge is driven by total taxation between the wage denominated in output prices and the take home consumption wage actually enjoyed by workers.

c) *The rate of unemployment*: The unemployment or Phillips curve effect in the LNJ model is a proxy for bargaining power. For example, unemployment is usually inversely related to the bargaining power of trades unions. The converse applies to employers.

d) *Labour productivity*: The productivity effect comes from workers' efforts to maintain their share of added value, i.e. to enjoy some of the gains from higher output per worker.

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

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

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.

(iv) Demographics and labour supply

Population growth can be endogenised through a "natural" growth rate, corrected for net additions or subtractions due to migration. Net migration flows are modelled using a standard Harris-Todaro approach that drives migration by the relative attractiveness of the local (or national) and international labour markets, where the latter can be proxied by an appropriate destination of migrants, e.g., the UK in the case of Ireland; Germany and France in other cases (Harris and Todaro, 1970). In the case of Estonia, probably internal migration (region <-> national) is probably as important, if not more important, than international migration. Attractiveness can be measured in terms of the relative expected wage, i.e., the product of the probability of being employed by the average wage in each region. 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.

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

3.3 Expenditure (or absorption) in the HERMIN model

(i) Private consumption

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

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

In other words, households are assumed to be liquidity constrained, in the sense of having very limited access to savings or credit in order to smooth their consumption. In later extensions of the HERMIN model, a more sophisticated approach was adopted.[13]

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

[13] For example, in the Irish HERMIN model, experiments were carried out with hybrid liquidity constrained and permanent income models of consumption. It was found that the long-run properties of the model were relatively invariant to the choice between a hybrid and a pure liquidity constrained function. However, if a forward looking model of wage income is used, the adjustment properties of the model change radically (Bradley and Whelan, 1997).

3.4 National income in the HERMIN model

(i) The public sector

With a view to its future use for policy analysis, HERMIN includes a conventional degree of institutional detail in the public sector. Within total public expenditure, we distinguish public consumption (mainly wages of public sector employees), social welfare income support transfers, subsidies, etc.), and capital expenditure (infrastructure, investment grants to industry).

(ii) The regional 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:

(3.11) $$YC = GDPFCV - YW$$

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:

(3.12) $$YP = GDPFCV + GTR$$

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

(3.13) $$YPER = YP – YCU$$

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

(3.14) $$YPERD = YPER - GTY$$

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

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

3.5 A stylised projection for 2004-2010

It is not our intention in this paper to produce a finely tuned realistic forecast for the Estonian economy for the remainder of the decade. Even if such an exercise were useful, it would require very detailed analysis of the external economic environment, the domestic Estonian 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 Estonian economy. Our intention here it merely to illustrate the projection methodology by making some fairly simple stylised assumptions, and inserting them into the current version of the Estonian HERMIN model.

Table 3.1 shows that the Estonian economy is likely to track external growth, with manufacturing growth exceeding the average. A "no-growth" assumption is made for the public sector..

Table 3.1: Sectoral output growth rates

Date	OW	GDPFC	OT	ON	OA	OG
2001	*1.68*	*6.36*	*10.56*	*7.36*	*-5.86*	*1.64*
2002	*1.99*	*6.93*	*13.91*	*6.40*	*-0.49*	*3.16*
2003	*8.18*	*6.53*	*10.46*	*7.27*	*-3.22*	*0.64*
2004	*8.45*	*7.50*	*10.69*	*8.06*	*1.65*	*1.47*
2005	5.00	4.86	7.65	4.91	4.32	0.00
2006	5.00	4.66	7.32	4.65	4.32	0.00
2007	5.00	4.76	7.40	4.71	4.32	0.00
2008	5.00	4.89	7.50	4.83	4.32	0.00
2009	5.00	5.05	7.63	4.98	4.32	0.00
2010	5.00	5.22	7.77	5.13	4.32	0.00

OW: "world"demand; 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

Projections for the levels on employment and unemployment are shown in Table 3.2. In this projection, employment levels in manufacturing, market services and the government sector are static, while employment in agriculture declines, albeit at a lower rate than in the past ten years. Consequently, the rate of unemployment is also fairly static, and remains at about 12 per cent of the labour force.

Table 3.2: Employment and unemployment levels (thousands)

Date	L	LT	LLN	LA	LG	LF	U	UR
2001	*572*	*134*	*284*	*39.50*	*115*	*662*	*89.50*	*13.52*
2002	*579*	*127*	*293*	*39.90*	*119*	*663*	*83.50*	*12.60*
2003	*588*	*134*	*293*	*36.20*	*126*	*664*	*75.70*	*11.40*
2004	*589*	*140*	*288*	*34.50*	*127*	*665*	*76.10*	*11.45*
2005	588	140	287	33.88	127	665	77.14	11.60
2006	586	140	286	33.27	127	665	78.99	11.88
2007	584	140	285	32.67	127	665	80.48	12.11
2008	583	140	284	32.09	127	665	81.47	12.26
2009	583	141	284	31.51	127	665	81.90	12.32
2010	583	141	284	30.94	127	665	81.74	12.30

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 3.3 we show the public and private sector balances, all expressed as percentages of GDP. The public sector borrowing requirement (measured in national accounting conventions rather than IMF conventions) remains fairly static, with a tendency to decline towards the later years. The trade balance (also expressed as a percentage of GDP, remains in deficit, but move gradually towards balance.

Table 3.3: Public and private sector imbalances

Date	GBORR	NTSVR
2001	2.55	-3.35
2002	1.14	-6.96
2003	3.86	-7.38
2004	3.84	-7.80
2005	3.18	-4.60
2006	2.73	-3.67
2007	2.25	-2.78
2008	1.77	-1.99
2009	1.27	-1.26
2010	0.75	-0.58

GBORR = public sector deficit (as % of GDP); NTSVR = net trade surplus (as % of GDP)

Finally, in Table 3.4 we illustrate the consequences for the inflation rate. The manufacturing price inflation is strongly anchored to the (assumed) world inflation rate (of 3 per cent). The inflation rate in market services – a fairly sheltered sector – has a tendency to drift above the world rate, due to the Balassa-Samuelson effect (i.e., higher productivity growth in manufacturing than in market services). Wage inflation continues to be high, driven by prices and by the high growth of productivity. But the inflation rate of unit labour cots is more modest, and real unit labour costs decline.

Table 3.4: The inflation environment (annual percentage change)

Date	PWORLD	POT	PON	PGDPFC	PCONS	WT	LPRT	ULCT	RULCT	WN
2001	*-0.34*	*3.70*	*5.75*	*5.64*	*6.13*	*10.61*	*6.75*	*4.46*	*0.73*	*10.68*
2002	*-1.42*	*0.03*	*4.65*	*4.21*	*3.15*	*24.08*	*19.46*	*2.39*	*2.36*	*6.16*
2003	*-1.19*	*1.54*	*0.72*	*2.22*	*0.70*	*6.43*	*5.33*	*1.32*	*-0.21*	*13.45*
2004	*0.34*	*3.43*	*2.59*	*3.67*	*3.17*	*7.09*	*5.85*	*0.13*	*-3.19*	*13.61*
2005	3.00	2.77	3.07	3.72	3.58	9.55	7.33	2.07	-0.68	9.55
2006	3.00	2.69	4.06	4.26	4.02	9.24	7.33	1.78	-0.89	9.24
2007	3.00	2.67	3.92	4.13	3.91	9.15	7.33	1.70	-0.95	9.15
2008	3.00	2.71	3.94	4.13	3.91	9.32	7.33	1.86	-0.83	9.32
2009	3.00	2.76	4.12	4.24	4.00	9.53	7.33	2.05	-0.69	9.53
2010	3.00	2.82	4.33	4.38	4.11	9.77	7.33	2.27	-0.53	9.77

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; WN = wage rate in market services (WNDOT=WTDOT)

The above projections are somewhat tentative in nature and should not be taken too seriously. When they are compared with any available "official" Estonian 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. However, in order to evaluate the macro impact of the Estonian SPD 2004-2006 on the economy, we need a baseline projection. The exact nature of the projection can always be revisited later.

[4] How the impact of structural funds is modelled in HERMIN

4.1 Introduction

Structural fund programmes consist of a multitude of individual complex measures. In order to be able to analyse the overall impact of the structural funds, it is therefore necessary to amalgamate these different measures into simpler and economically meaningful categories, for the following reasons.

1) Although it is necessary to present a structural fund programme in great administrative detail for the purposes of planning, implementation and monitoring, there is less rationale for this detail from an economic analysis perspective.

2) If the unit of analysis is Estonia, there is no requirement to distinguish, say, the impact of a new road in one sub-region of as compared with another sub-region.

3) If the structural fund expenditures are aggregated into economically meaningful categories, one can make use of research on the impacts of public investment on the performance of the private sector.

A very simple and useful categorisation amalgamates the measures into just three categories namely:

i. Investment expenditures on physical infrastructure
ii. Investment expenditure on human resources
iii. Expenditures on direct production/investment aid to the private sector

Within each of these three economic categories there are three possible sources of funding:

a) EU transfers in the form of subventions to domestic public authorities;
b) Domestic public sector co-financing as set out in the structural fund treaties;
c) Domestic private sector co-financing as set out in the structural fund treaties.

Inclusion of the private sector co-financing is at best problematic, and it is usually ignored in impact analysis. Of course, there are indirect impacts of publicly financed structural fund investments on private sector investment and other private sector activities, and these are already included in the analysis as part of the behavioural properties of the HERMIN model. However, since considerable uncertainty and ambiguity surrounds the driving mechanisms behind the private sector structural fund expenditures, and since no methodology exists to model them explicitly, they are best excluded from an impact evaluation exercise.

Structural fund actions influence economies through a mixture of supply and demand channels. Short-term demand (or Keynesian) effects arise as a consequence of increases in the expenditure and income policy instruments associated with structural fund policy initiatives. Through the "multiplier" effects contained in the models, there will be knock-on increases 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 core *raison d'être* of the structural funds, but merely a side-effect. Rather, the structural fund interventions are intended to influence the long-run supply potential of the economy.

The so-called "supply-side" effects arise through policies designed to:

i. increase investment in order to improve the stock of physical infrastructure as an input to private sector productive activity;

ii. increase in the "stock" of 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 structural fund interventions are designed to improve the aggregate stock of public infrastructure and human capital, as well as the efficiency of the private capital stock and private sector activity more generally. Providing more and better infrastructure, increasing the quality of the labour force, or providing direct investment aid to private firms, are the mechanisms through which the structural funds improve the output, productivity and cost competitiveness of an economy. 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 structural fund interventions.

Recent advances in growth theory have addressed the role of spillovers or externalities which arise from public investments in human capital and infrastructure. Furthermore this literature has investigated how technical progress can be affected directly through investment in research and development (R&D). Here too externalities arise when innovations in one firm are adopted elsewhere, i.e., when such innovations have public good "non-rivalous" qualities. These externalities have an important implication for the long-run impact of the structural funds. Properly to assess the impact of the funds requires that these externalities be incorporated into the modelling framework that is chosen.

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. This is referred to as an <u>output externality</u> 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. This is referred to as a <u>factor productivity externality</u>. A side effect of increased factor productivity is that, in the artificially restricted context of a fixed level of output, labour must be shed.[14] The prospect of such "jobless

[14] Employment (L) can be thought of as determined by the identity: L = O/PR, where O is output and

growth" is particularly serious in economies where the recorded rate of unemployment as well as the rate of hidden unemployment is already high. 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 growth also remains weak. However, if factor productivity is driven up, real incomes will rise, and these effects will cause knock-on multiplier and other benefits throughout the economy. Hence, the role of the output externality is more unambiguously beneficial than the factor productivity elasticity. But in both cases, these externality effects promote faster transitional growth to a higher income plateau.

The elasticities relating the beneficial externality effects to the structural fund investments, particularly in relation to infrastructure, have been chosen on the basis of an exhaustive literature review (see Bradley *et al*, 2004 for details). 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 small regions at the lower end of the scale. With respect to human capital, elasticities in the same range also appear reasonable.

Since the empirical research that yields estimates of such elasticities does not exist for many regions and some less developed countries, those for more advanced economies sometimes have to be utilised as proxy substitutes. However, sensitivity analysis has been carried out and is discussed later. The infrastructure deficit in Objective 1 countries such as Estonia is often quite large relative to the more developed regions of the EU. Given this, as well as the fact that there are substantial returns to the elimination of bottlenecks, which will take some time to accomplish, it is reasonable to expect that the chosen elasticities will capture the benefits properly over the time period for which the simulations have been carried out. For the same reasons it is unlikely that diminishing returns will set in.

4.2 Linking the externality mechanisms into the HERMIN model

4.2.1 Direct 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 new EU member states and regions. The treatment of the manufacturing sector in HERMIN assumes a supply side approach in which the share of the world's output being allocated to, or generated within, a peripheral region is determined by measures of local and external 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 a specific region 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 region,

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PR is labour productivity. If O is fixed, and PR increases, then L must decline. But in the real world there will be other factors that will tend to drive O up. For example, during implementation of the Structural Fund programmes there will be a demand stimulus. So the eventual outturn for L can only be determined by simulating the model, and taking account of all factors that influence output and productivity.

while competitiveness decides how many of the industries which can locate in the region 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 original equation determining OT is 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 external (or world) demand, FDOT represents the influence of local regional absorption, ULCT/POT represents real unit labour costs, POT/PWORLD represents cost competitiveness, and t is a time trend (picking up all other systematic factors, such as sectoral restructuring). To take account of output externalities associated with infrastructure and human capital, the following two terms are added to the right-hand side of 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).[15] For the present we ignore any interactions and complementarities that may exist between physical infrastructure and human capital, since so little is yet known about this aspect of the SPD.[16]

Such a modification attempts to capture the notion that a 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 SPD may improve the quality of goods produced locally and thus improve the demand for goods produced by firms already located in the region, whether foreign or indigenous.

4.2.2 Indirect factor productivity externalities

The first type of externality mechanism, treated above, boosts output directly. The second type of mechanism works indirectly through improving factor productivity. Factor productivity externalities can be associated with improved supply conditions in the economy, brought about as a result of investment in human capital and public infrastructure. These are incorporated into HERMIN by modifying the production technology in manufacturing and

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15 Thus, if the stock of infrastructure increases by 1 per cent relative to the baseline stock, output in manufacturing (OT) is boosted directly 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 directly by η_2 per cent

16 The possible interaction between physical infrastructure and human capital is potentially of great importance, and is at the centre of the optimality of the SPD design. However, almost nothing is known of these complementarities.

market services. This technology is modelled in HERMIN by means of the CES (or Constant Elasticity of Substitution) production function.[17] A simple way of doing this is to endogenise 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 are likely to 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 local 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:

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

where A_0 is the original (i.e., pre-SPD) 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 SPD infrastructural investments made during the period under consideration.

Similarly, the SPD 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 SPD 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.[18]

[17] Most studies use the simpler Cobb-Douglas production function, where the restriction of a unit elasticity of substitution is imposed. For an example showing why this is too restrictive for small open economies, see Bradley and Fitz Gerald, 1988.

[18] The macro output effects of a poorly designed training scheme, whose implementation was measured in terms of inputs, would show up in the form of very low externality elasticities. In other words, the macro benefits would be merely the short-run Keynesian income-expenditure ones.

Suppose we assume that, prior to the implementation of the SPD the number of labour force participants trained to a specified level, $NTRAIN_0$, is known. If the ESF element of the SPD is used to train an additional number of people, giving a total of $NTRAIN_t$ trained labour force participants 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.

4.3 Handling SPD physical infrastructure impact analysis

The HERMIN model assumes that any SPD-based expenditure on physical infrastructure that is directly financed by EU aid subvention (IGVCSFEC) is matched by a domestically financed public expenditure (IGVCSFDP).[19] Hence, the total public SPD infrastructural expenditure (IGVCSF) is defined in the model as follows (in current prices):

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

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

$$\text{KGINF} = \text{IGINF} + (1\text{-}\delta) * \text{KGINF}(\text{-}1)$$

where δ is the assumed rate of capital stock depreciation (e.g., 2 per cent per year).[20] This accumulated stock is divided by the (exogenous) baseline non-SPD stock ($KGINF_0$) to give the SPD-related relative improvement in the stock of infrastructure (KGINFR):

$$\text{KGINFR} = \text{KGINF} \,/\, \text{KGINF}_0$$

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 SPD, the total cost of the increased public expenditure on infrastructure (IGVCSF) is added to the domestic public sector capital expenditure (GK). Any increase in the domestic public sector deficit (GBOR) is limited by the extent of EU SPD-related aid subventions (IGVCSFEC). Whether or not the post-SPD public sector deficit rises or falls relative to the no-SPD 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 country to country as well as from programme to programme.

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[19] We ignore all private sector co-finance (see previous discussion).

[20] Public infrastructure is usually assumed to have a lower rate of depreciation than private capital stock. Typically, a 2 per cent rate is assumed for public infrastructure, and rates in the region of 5 per cent for private capital.

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

We can now switch in various externality effects to augment the conventional demand-side impacts of the SPD 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-SPD) projected level (KGINFR), i.e.,

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

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 appendix to this section for details). In any model-based simulations, the externality effects can be phased in linearly over an extended period, reflecting the implementation stages of the SPD programmes and the fact that benefits from improved infrastructure may only be exploited with a lag by the private sector in terms of increased activity.

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

i. The <u>direct</u> 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. <u>Total factor productivity</u> (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 for given factor inputs. However, the second type is likely to have a negative down-side, since labour will be shed as total factor productivity improves, unless output can be increased sufficiently to offset this loss. Inevitably production will become less labour intensive in a process that has only limited analogues in the more developed and technologically advanced economies in the EU core.[21]

4.4 Handling SPD human resources impact analysis

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

[21] The more advanced EU economies went through a process of industrial restructuring in an earlier era. In those regions that suffered from “de-industrialisation, such as northern France, Southern Belgium, coal mining and steel producing regions of the UK, the previous Structural Funds had designated programmes that attempted to address the regional problems (Objective 2).

$$GTRSF = GTRSFEC + GTRSFDP$$

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) becomes a part of the broader category of public expenditure on income transfers (GTR). However, the increase in the domestic public regional deficit (GBOR) is limited by the extent of SPD aid subventions by the EC (GTRSFEC).

Since the complex institutional detail of the many ESF human resource training and education programmes cannot be handled in a small macroeconomic model like HERMIN, one needs to simplify drastically.

i. Each trainee or participant in a training course is assumed to be paid an average annual income (WTRAIN), taken to be a fraction (half) of the average industrial wage (WT);

ii. Each instructor is assumed to be paid the average annual wage appropriate to the market service sector (WN);

iii. We assume an overhead of 50 per cent on total wage costs to take account of buildings, equipment, materials, etc (OVERHD);

iv. We assume a fixed trainee-instructor ratio of 15:1 (TRATIO).

Hence, total SPD 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.[22] This formula is inverted in the HERMIN model and used to estimate the approximate number of extra trainees that can be funded by the SPD for a given total expenditure GTRSF on human resources, i.e.,

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

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

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

The number of SPD-funded trainees (measured in trainee-years) is accumulated into a 'stock' (KSFTRAIN) by means of a perpetual inventory-like formula, with a ‘depreciation’ rate β:[23]

$$KSFTRAIN = SFTRAIN + (1-\beta) * KSFTRAIN(-1)$$

In order to quantify the increase in the stock of human capital (measured in trainee years), we need to define the initial pre-SPD stock of human capital, $KTRAIN_0$. This is a conceptually

[22] Even if we were able to obtain full details of the inputs and outputs of the ESF training schemes, the HERMIIN-type simplification would still be of use since it “endogenises” the ESF schemes in the macro impact simulations in a way that would be very difficult to do with the ex-post ESF data.
[23] Human capital (measured by accumulated years training) can “depreciate” in the sense that people may leave the labour force, and as time passes, the usefulness of the previous training is diminished.

difficult challenge, and we are again forced to simplify drastically.[24] 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 SPD. We can cut through the complex details of the education system and stylise it 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[25]

YHS = standardised number of years higher secondary cycle
FHS = fraction of population with higher secondary education
DHS = "discount" factor for years of higher secondary cycle

YNUT = standardised number of years in non-university tertiary cycle
FNUT = fraction of population with non-university tertiary education
DNUT = "discount" factor for years of non-university tertiary cycle

YUT = standardised number of years in university tertiary cycle
FUT = fraction of population with university tertiary cycle
DUT = "discount" factor for years university tertiary cycle

The accumulated stock of SPD 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 SPD human resources programmes:

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

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

In the absence of any externality mechanisms, the HERMIN model can only calculate the income-expenditure effects of the SPD human resource programmes. These effects are limited in magnitude, particularly in countries where the income multipliers are small (e.g.,

[24] Our earlier attempts to address the quantification of the stock of human capital have been revised in light of the recent literature on human capital (e.g., Sinaesi and Van Reenen, 2002). The earlier simulations understated the initial pre-CSF stock level of human resources, and consequently exaggerated the impacts of the ESF-funded training schemes.

[25] 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 productivity-enhancing human capital.

small open economies). In addition, a sizeable fraction of the SPD payments to trainees may simply replace existing unemployment transfers. The 'overhead' element of these programmes (equal to OVERHD*SFWAG) is assumed to boost non-wage public consumption and investment directly.

The HERMIN model introduces externality effects to augment the demand-side impacts of the SPD 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-SPD) projected level, i.e.,

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

here η is the externality elasticity. In the model-based simulations, the externality effects can be phased in linearly over an extended period, reflecting the implementation stages of the SPD 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:[26]

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-SPD 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.

4.5 Handling SPD direct aid to the productive sectors

The third, and final, category of SPD expenditure concerns direct aid made available to the two main productive sectors: manufacturing and market services. In previous SPDs, aid was also channelled to the agriculture sector, but this will be discontinued in the forthcoming *CP* and *CF* programmes for 2007-2013.

These expenditures cover a very wide rage of activities. For example, in the Irish SPD 1994-2000, they covered programmes in indigenous industry (company development, inter-company linkages, business innovation centres,), inward investment (investment grants), research and development, marketing, tourism, etc.[27] These programmes undoubtedly benefit

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[26] It is well known that untrained and/or unskilled workers compete in the labour market in a very ineffective way, and are much more likely to end up as long-term unemployed than are skilled/trained workers (Layard, Nickell and Jackman, 1991). We assume that all ESF trainees are in the unskilled or semi-skilled category, and that their temporary removal from the labour force for the duration of their training scheme has almost no effect on wage bargaining behaviour through the Phillips curve 'pressure' effect in the HERMIN wage equation. 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), and is implemented in the HERMIN model by defining a 'corrected' measure (URP) of the unemployment rate (UR) for use in the Phillips curve.

[27] For a more detailed account of the coverage of direct aid to the Irish productive sectors, see

the recipient countries. But given their heterogeneous nature, it is very difficult to summarise their likely impacts in the way that we can do for physical infrastructure and human resources.

We handle these expenditures as follows. We aggregate the EC and domestic co-financing elements into two sectoral components: TRIT for manufacturing and TRIN for market services. These two expenditures are converted to constant prices inside the model, and are simply added to the sectoral investment variables as a kind of positive “shock”. So, they have demand-side impacts, but no supply-side externality mechanisms are assumed to operate. What this means is that we are probably understating the likely impacts of well-designed and well-targeted direct aid programmes. But if these programmes are badly designed, and split into many small-scale ineffective programmes, they are unlikely to have permanent impacts.

Honohan, (ed.), 1997.

[5] Evaluating the impacts of SPD 2004-2006

5.1 Background to the policy analysis simulations

The first step requires us to set up a baseline scenario for the Estonian economy. In theory, the assumptions used in this baseline should be identical to the subsequent "with-*SPD"* simulation, with one exception. Namely, the *SPD* expenditure is set at zero in the baseline. This baseline was illustrated in section 3 above. In practice, the definition of a "no-SPD" baseline is fraught with conceptual difficulties (see below).

The second step requires the execution of the *SPD* policy scenarios, based on the funding guidelines provided by the Estonian authorities in their SPD documentation, using the regional HERMIN model.

The manner in which we execute the macro-sectoral impact evaluation (relative to the zero base assumption) exercise is as follows:

i. Using the Estonian HERMIN model, we carry out a baseline model simulation, starting in the year prior to the most recent historical data that is available (2003). We continue the model simulation to the year 2010, i.e., four years after the termination of the 2004-2006 SPD programme. A series of "stylised" assumptions are made for all the international variables as well as for all the local domestic policy variables. Since no previous forecasts of a medium-term orientation have been prepared, this is a somewhat speculative exercise that will have to be re-visited at a later stage in the evaluation of the Estonian SPD.

ii. The baseline is taken as being representative of the case of no *SPD* funds. It must be stressed that the "no *SPD*" case is very artificial, since in the absence of any EU-supported programme, there almost certainly would be a substitute domestically funded public investment programme, albeit smaller in magnitude.[28]

iii. We then set the *SPD* funds at their values (as given in Section 2), and re-simulate all the model.

iv. The "no-*SPD*" simulation results are subtracted from the "with-*SPD*" simulation results, and this is used as a measure of the contribution of the *SPD*.

An important point concerns the set of "standardised" policy choices made in the with *SPD* simulations. These mainly involve the externality elasticities, which are key influences on the longer term supply-side impacts of higher levels of the stock of physical infrastructure and of human capital.. These are set initially at values that are "average" for international studies. What this means is the following:

[28] It might be held that, in the absence of such large-scale public policy shocks, the underlying structure of the economies would have changed and that the use of HERMIN models calibrated with historical CSF-inclusive data is invalid (the so-called "Lucas critique" of the use of econometric models to analyse policy impacts). However, the HERMIN models contain explicit sub-models of the structural changes that are associated with the operation of the CSF, so the validity of the Lucas critique is weakened.

i. In the case of “output” externalities, a value of 20 per cent was selected, as being broadly in the mid-range of the international estimates. Hence, an increase in either the stock of physical infrastructure or of human capital of 1 per cent will directly increase manufacturing output by 0.2 per cent. There are no direct impacts on other sectoral outputs (market services, agriculture and government). But there will obviously be indirect knock-on demand-side impacts on market services.

ii. In the case of “factor productivity” externalities, a value of 10 per cent was selected, as being broadly in the mid-range of the international estimates. Hence, an increase in either the stock of physical infrastructure or of human capital of 1 per cent will directly increase factor productivity in manufacturing and market services by 0.1 per cent.

A series of three other “technical” assumptions are made, which we reiterate:

a) It is assumed that 50 per cent of expenditure on training is in the form of an overhead, covering buildings, equipment, etc.

b) It is assumed that trainees are paid an amount of half the average manufacturing wage while they participate in training courses, and this appears as an income transfer item in the public sector accounts.

c) The trainee/trainer ratio is assumed to be 15:1, and trainers are assumed to be paid the average wage in market services.

5.2 The simulation results: medium spillover case

The simulation results for the case of “average” spillover effects are presented in the Annex to this section (Table 5.1). The variable short-hand notation is shown on the first page of the Annex. Clearly there is a huge amount of information contained in this table, and we explain the notation below..

In Table 5.1 in the appendix to this section, the first two variables (**GDPM/g** and **L/g**) show the annual growth rate of GDP and growth rate of total employment in the baseline (no-SPD) simulation.

The next two variables and show the EC finance (**GECSFRAE/l**), as well as the “EC plus domestic co-finance” (**GECSFRAP/l**), both of which are expressed as a percentage of Estonian GDP.

The next two variables give an indication of the percentage change in the stocks of physical infrastructure (**KGINFR/p**) and human capital (**KTRNR/p**) caused by the *SPD* policy shock.[29]

The next four variables provide measures of the impact of the policy shock on the aggregate economy:

[29] We stress that the KGINFR and KTRNR measures are constructed in a way that makes them only broad indicators of the underlying “real” capital stocks that are not measurable. For details of the approach, see Bradley, Petrakis and Traistaru, 2004.

i. **GDPM/p** shows the percentage change in the level of GDP relative to the "no-shock" baseline. It should be stressed that the HERMIN methodology analyses the shift in the level of GDP caused by the *SPD* shock. Thus, there can be (and usually is) a semi-permanent rise in the level of GDP as a result of the SPD programmes. But the growth rate of GDP is only changed temporarily (as the economy adjusts from the lower to the higher level), and there is no long-term change in the growth rate. A similar point applies to all the impact analysis.[30]

ii. **L/p** shows the percentage change in the level of total employment relative to the "no-shock" baseline;

iii. **L/d** shows the absolute change in the level of total employment relative to the "no-shock" baseline (all employment is measured in thousands);

iv. **LPROD/p** shows the percentage change in the level of aggregate productivity relative to the "no-shock" baseline.

The next set of four variables repeats the previous aggregate measures, but applied specifically to the manufacturing sector:

i. **OT/p** shows the percentage change in the level of GDP in manufacturing relative to the "no-shock" baseline;

ii. **LT/p** shows the percentage change in the level of employment in manufacturing relative to the "no-shock" baseline;

iii. **LT/d** shows the absolute change in the level of employment in manufacturing relative to the "no-shock" baseline (all employment is measured in thousands);

iv. **LPRT/p** shows the percentage change in the level of productivity in manufacturing relative to the "no-shock" baseline.

The next set of four variables repeats the previous manufacturing measures, but now applied specifically to the market services sector. It should be stressed that this sector in HERMIN includes all building and construction activities. Consequently, activity in this sector is boosted during the implementation phases of the *SPD* programmes, but tends to fall back after the programmes are cut off abruptly at the end of the year 2006.:

i. **ON/p** shows the percentage change in the level of GDP in market services relative to the "no-shock" baseline;

ii. **LLN/p** shows the percentage change in the level of employment in market services relative to the "no-shock" baseline;

iii. **LLN/d** shows the absolute change in the level of employment in market services relative to the "no-shock" baseline (all employment is measured in thousands);

[30] See Sinaesi and Van Reenen (2002) for material on the "level" versus "growth rate" impacts of human capital shocks. This debate remains unresolved. The adoption of the "levels" approach (as in HERMIN) is the conservative one.

iv. **LPRN/p** shows the percentage change in the level of productivity in market services relative to the "no-shock" baseline.

The next two variables measure the impact of the policy shock on the two major expenditure aggregates: household consumption and total investment:

i. **CONS/p** shows the percentage change in the level of household consumption relative to the "no-shock" baseline;

ii. **I/p** shows the percentage change in the level of total fixed investment relative to the "no-shock" baseline;

The next five variables examine the impacts of the policy shock on prices and wages;

i. **PGDPFC/p** shows the percentage change in the level of the deflator of aggregate GDP relative to the "no-shock" baseline;

ii. **POT/p** shows the percentage change in the level of the deflator of manufacturing GDP relative to the "no-shock" baseline;

iii. **PON/p** shows the percentage change in the level of the deflator of market services GDP relative to the "no-shock" baseline;

iv. **PCONS/p** shows the percentage change in the level of the deflator of household consumption relative to the "no-shock" baseline;

v. **WT/p** shows the percentage change in the level of average earnings in manufacturing relative to the "no-shock" baseline;

The final two variables give the impact of the policy shock on the trade and the public sector balances:

i. **NTSVR/d** shows the absolute change in the net trade surplus, expressed as a percentage of GDP, relative to the no-shock baseline;.

ii. **REGDEFR/d** shows the absolute change in the regional public sector balance, expressed as a percentage of GDP, relative to the no-shock baseline.

Table 5.1 shows that the impact of the policy shock, using mid-range spill-over elasticities, is quite strong while the investment programmes are actually being implemented (i.e., between the years 2004 and 2006). The impact on regional GDP (GDPM/p in Table 5.1) peaks in the year 2006, with an increase of almost 2.5 per cent in the level of GDP, and of 1.7 per cent in the level of total employment. However, when the programme terminates, and the *SPD* investment expenditures are assumed (quite unrealistically, of course) to cease completely, the increase in the level of GDP falls back to about 0.5 per cent. Since the policy impacts are productivity-enhancing, the long-run increase in the level of total employment falls off faster than output, and is effectively zero after 2006. But meanwhile, the level of aggregate productivity has increased by almost 0.7 per cent by 2006.

The HERMIN model permits us to decompose the aggregate impacts into the separate impacts on manufacturing and on market services.[31] Since building and construction activities are part of the market service sector (N), the impact on output in this sector during the period 2004-06 is significant (at between 1.5 and 2.5 per cent between 2004 and 2006). But when the programmes cease, the activity level falls off rapidly, and the sustained rise in the level of N-sector GDP is effectively zero. During the implementation phase, the impact on the level of manufacturing output is also large, and peaks at about 2.7 per cent in 2006. But the rise is more sustained than in market services, and by 2010 manufacturing GDP is still over 0.8 per cent higher than the no-shock baseline. Consequently, even with strong productivity growth, manufacturing employment levels remain at about 0.5 per cent higher than the baseline for an extended period, but there are no long-term employment effects in market services.[32]

The implications for the expenditure side of the economy are shown by the impacts on household consumption (CONS/p) and total fixed investment (I/p).[33] The boost to consumption is strong, peaking at a rise of about 3.4 per cent in 2006, but falling off rapidly thereafter, and ending at the baseline value by 2010. Since the policy shock is one of increased public investment, the overall impacts on total investment (public and private) is very strong during the implementation years, peaking at a rise of 8 per cent in 2006, but also falls off to a very small long-run increase in the level of investment. Obviously in the post-2006 years, this is an increase in purely private sector investment (i.e., manufacturing and market services).

There are some transitory and minor inflationary consequences of the policy shock. Prices in the “exposed” manufacturing sector in Estonia (POT) are strongly anchored to world prices, so the price level shows little change. But the more “sheltered” market services sector (which includes the “booming” building and construction sector) suffers a rise in the level of prices of nearly 3 per cent. Much of this rise comes from wage increases. The level of average annual earnings in manufacturing – a key sector in wage bargaining – is almost 4 per cent higher by the year 2013 than in the baseline case, but the long-run rise is only 0.25 per cent above the baseline level.

Finally, during the planned SPD implementation years 2004-2006, the trade balance deteriorates relative to the baseline, as the expenditure of Structural Funds sucks in imports to the region. The deterioration in the trade balance is largest in the year 2006 at 1.4 percentage points of GDP, but balance is restored after the programme terminates, and there is a small surplus relative to the baseline case. The public sector borrowing requirement (GBORR) improves modestly during the implementation and post-implementation years, due mainly to the revenue buoyancy generated by the SPD expenditures and high level of the EC contribution relative to the domestic public co-financing.

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[31] The agriculture sector in HERMIN is fairly static, and tends to function almost independently of the rest of the economy. With the rural aid schemes, it is modestly affected by the policy shock. The government sector is instrumental, and involved to a modest extent in the delivery of training programmes.

[32] It is well known that growth in market service sector activities is likely to be strong in the new EU member states. But our simulations are only looking at the specific impacts of an SPD policy shock, and abstract from these other background changes.

[33] Note that total fixed investment (I) includes public sector investment, as well as private sector investment in manufacturing, market services and agriculture. The public element (IG) contains most of the SPD infrastructural programmes, that are produced in the building and construction sub-sector of market services and form part of N-sector output.

The corresponding results for the "actual" SPD expenditures for the years 2004-2005, using mid-range spillover elasticities, are presented in Annex 5.2. Since so little of the planned SPD expenditure programmes were actually implemented by end 2005, the effects are modest compared to the impacts of the planned SPD expenditures, based on the same assumptions for the spill-over elasticities.

For example, the SPD impact on GDP in the year 2005 in the "planned" case was 1.9 per cent above the baseline level of GDP. In the "actual" case, it was only 0.9 above the baseline level of GDP. The increase in total employment in the "planned" case was 8,120 jobs, but only 4,020 jobs in the "actual" case. In neither case is the job creation sustained beyond the termination of the SPD.[34]

5.3 The simulation results: Zero and High spillover cases

Annex S5 also presents two extreme cases of the assumptions concerning the externality (spillover) assumptions for the Estonian SPD. In the Zero case (Table 5.2) we assume that there are no positive spillovers, and the all impacts of the SPD investments vanish after the implementation stage is over (i.e., after 2006).

In Table 5.3 we assume that the output spillover is twice as large as in the Medium case (i.e., 40 per cent instead of 20 per cent), the productivity spillover in manufacturing is 20 per cent, but that the productivity spill-over in market services remains at the lower value of 10 per cent. In this case there are much larger output impacts, and these impacts generate significant employment impacts (since productivity in the largest sector in terms of employment has not increased over and above the previous "medium" case.

5.4 Cumulative multipliers: Zero, Medium and High spillover cases

Perhaps the best summary of how the *SPD* policy shocks impact on an economy is given by the "cumulative" multiplier. The cumulative *SPD* multiplier attempts to capture the continued (if modest) semi-permanent increase in the level of GDP that should persist after the policy is terminated after the year 2006. Its definition is as follows:

$$Cumulative \quad SPD \ multiplier \quad \Rightarrow \frac{Cumulative \quad \% \, increase \quad in \, GDP}{Cumulative \quad SPD \ share \ in \, GDP}$$

The resulting calculations are shown in Table 5.5 below, in the case of Medium spillover effects. In the year 2004, the planned EC and domestically co-financed expenditures in the Estonian SPD amounted to 1.31 per cent of GDP (see the variable GECSFRAP in Table 5.1). The impact in that year is to increase GDP by 1.36 per cent.[35] The resulting SPD multiplier is

[34] It should be realised, of course, that other factors, unrelated to the actual SPD expenditures, are very likely to drive up employment (e.g., foreign direct investment, trade integration, etc.).

[35] It is assumed that the spillover effects pass through to the economy gradually during implementation, and the full effect take four years to be established. This is an approximate way of taking account of the fact that large-scale infrastructure projects take some time to deliver

1.04 for the initial year. As the programme is implemented over the subsequent years, the annual EC and domestic funding (always expressed as a percentage of GDP) is accumulated, and grows steadily until the year 2006, when it reaches 4.84 per cent of GDP. By that stage, the accumulated percentage increase in GDP reaches 5.77 (Medium case). After the year 2006. the SPD expenditures are assumed to cease, and the share remains constant at 4.84 per cent of GDP. But the increases in GDP continue, driven by the spillovers from the improved stock of physical infrastructure and human capital. The cumulative multiplier continues to rise, and ends up in the year 2010 at a value of 1.44.

Table 5.4: Derivation of cumulative multipliers (Medium spillovers)

Date	GECSFRAP	GDPM	CumSPD	CumGDP	CumMult
2003	0.00	0.00	0.00	0.00	0.00
2004	1.31	1.36	1.31	1.36	1.04
2005	1.62	1.91	2.94	3.28	1.12
2006	1.90	2.49	4.84	5.77	1.19
2007	0.00	0.50	4.84	6.26	1.29
2008	0.00	0.33	4.84	6.59	1.36
2009	0.00	0.19	4.84	6.78	1.40
2010	0.00	0.18	4.84	6.96	1.44

competitiveness-enhancing benefits.

Annex 1 to Section 5: Simulation Results for Planned SPD 2004-06

Variable notation: Qualifiers

The tables show the "with *SPD*" case (henceforth "with") relative to the "without *SPD*" case (henceforth "without"). The following notation is used:

i. Where the variable name is qualified by "/p", this means that the results are percentage changes relative to the no-SPD baseline;

ii. Where "/g" is shown beside a variable name, this indicates that a simple annual growth rate is shown (i.e., growth in the variable over time, and NOT relative to any baseline);

iii. Where "/l" is shown beside a variable name, this indicates a level of the variable in the "with *SPD*" simulation;

iv. Where "/d" is shown beside a variable name, this indicates a difference relative to the baseline. For example, "L/d" indicates that this is the change in numbers employed (expressed in thousands) in the "with" simulation relative to the "without" simulation.

Variable notation: Names

GDPM	Aggregate gross domestic product (constant prices)
L	Aggregate employment
UR	Unemployment rate
GECSFRAE	*SPD* funding as a percentage of GDP (EC element)
GECSFRAP	*SPD* funding as a percentage of GDP (EC+domestic element)
KGINGR	"Stock" of physical infrastructure
KTRNR	"Stock" of human capital
LPROD	Aggregate labour productivity
OT	GDP produced in manufacturing (constant prices)
LT	Employment in manufacturing
LPRT	Labour productivity in manufacturing
ON	GDP produced in market services (constant prices)
LLN	Employment in market services
LPRN	Labour productivity in market services
CONS	Household consumption (constant prices)
I	Total fixed investment (constant prices)
PGDPFC	Deflator of aggregate GDP
POT	Deflator of GDP in manufacturing
PON	Deflator of GDP in market services
PCONS	Deflator of household consumption
WT	Average annual earnings in manufacturing
NTSVR	Net trade surplus expressed as a percentage of GDP
GBORR	Public sector deficit expressed as a percentage of GDP

Table 5.1: Medium spillover effects: SPD terminated after 2006

Date	GDPM /g	L /g	GECSFRAE /l	GECSFRAP /l	KGINFR /p	KTRNR /p
2003			0.00	0.00	0.00	0.00
2004	7.81	0.10	1.00	1.31	0.92	0.45
2005	4.72	−0.18	1.22	1.62	2.05	0.98
2006	4.55	−0.32	1.44	1.90	3.36	1.59
2007	4.65	−0.25	0.00	0.00	3.13	1.51
2008	4.79	−0.17	0.00	0.00	2.95	1.44
2009	4.96	−0.07	0.00	0.00	2.81	1.37
2010	5.14	0.03	0.00	0.00	2.68	1.30

Date	GDPM /p	L /p	L /d	LPROD /p
2003	0.00	0.00	0.00	0.00
2004	1.36	1.06	6.23	0.25
2005	1.91	1.38	8.12	0.43
2006	2.49	1.70	9.96	0.65
2007	0.50	0.08	0.46	0.38
2008	0.33	−0.02	−0.12	0.35
2009	0.19	−0.10	−0.59	0.31
2010	0.18	−0.09	−0.55	0.30

Date	OT /p	LT /p	LT /d	LPRT /p	ON /p	LLN /p	LLN d	LPRN /p
2003	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2004	1.31	1.23	1.72	0.08	1.43	1.43	4.12	0.00
2005	1.85	1.63	2.29	0.21	2.00	1.86	5.34	0.14
2006	2.65	2.22	3.11	0.42	2.54	2.19	6.27	0.34
2007	0.92	0.49	0.68	0.43	0.40	−0.08	−0.23	0.48
2008	1.04	0.57	0.81	0.47	0.16	−0.33	−0.93	0.48
2009	0.87	0.44	0.62	0.43	0.02	−0.43	−1.21	0.44
2010	0.84	0.43	0.61	0.41	0.02	−0.41	−1.16	0.43

Date	CONS /p	I /p	PGDPFC /p	POT /p	PON /p	PCONS /p	WT p	NTSVR d	GBORR /d
2003	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2004	1.75	4.84	0.47	0.28	0.42	0.38	1.22	−1.05	−0.10
2005	2.58	6.51	1.56	0.66	1.69	1.26	2.86	−1.31	−0.16
2006	3.40	8.07	2.46	0.82	2.90	1.98	3.76	−1.38	−0.24
2007	0.77	0.99	2.12	0.47	2.76	1.70	2.33	0.27	−0.13
2008	0.35	0.28	0.72	0.00	1.09	0.58	0.49	0.28	−0.07
2009	0.04	0.01	−0.08	−0.04	−0.14	−0.07	0.26	0.07	0.01
2010	0.03	0.03	−0.19	−0.06	−0.28	−0.16	0.16	0.04	0.04

Table 5.2: Zero spillover effects: SPD terminated after 2006

Date	GDPM /g	L /g	GECSFRAE /l	GECSFRAP /l	KGINFR /p	KTRNR /p
2003	na	na	0.00	0.00	0.00	0.00
2004	7.81	0.10	1.00	1.31	0.92	0.45
2005	4.72	−0.18	1.22	1.62	2.05	0.98
2006	4.55	−0.32	1.44	1.91	3.35	1.60
2007	4.65	−0.25	0.00	0.00	3.13	1.52
2008	4.79	−0.17	0.00	0.00	2.95	1.44
2009	4.96	−0.07	0.00	0.00	2.80	1.37
2010	5.14	0.03	0.00	0.00	2.67	1.30

Date	GDPM /p	L /p	L /d	LPROD /p
2003	0.00	0.00	0.00	0.00
2004	1.35	1.06	6.25	0.23
2005	1.84	1.40	8.21	0.34
2006	2.30	1.73	10.16	0.43
2007	0.25	0.11	0.66	0.10
2008	0.03	0.01	0.09	0.01
2009	−0.11	−0.07	−0.42	−0.02
2010	−0.11	−0.07	−0.40	−0.02

Date	OT /p	LT /p	LT /d	LPRT /p	ON p	LLN /p	LLN /d	LPRN /p
2003	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2004	1.25	1.20	1.67	0.05	1.43	1.46	4.19	−0.03
2005	1.57	1.49	2.08	0.08	1.97	1.96	5.64	0.01
2006	1.97	1.85	2.59	0.11	2.47	2.44	6.98	0.03
2007	0.07	0.02	0.03	0.04	0.30	0.22	0.63	0.08
2008	0.03	0.02	0.02	0.01	0.04	0.02	0.06	0.01
2009	−0.10	−0.10	−0.14	−0.01	−0.11	−0.10	−0.28	−0.01
2010	−0.09	−0.08	−0.12	0.00	−0.10	−0.10	−0.28	0.00

Date	CONS /p	I /p	PGDPFC /p	POT p	PON /p	PCONS /p	WT /p	NTSVR /d	GBORR /d
2003	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2004	1.74	4.84	0.47	0.29	0.42	0.38	1.20	−1.06	−0.10
2005	2.50	6.48	1.57	0.66	1.71	1.26	2.77	−1.32	−0.15
2006	3.21	7.99	2.49	0.84	2.96	2.00	3.53	−1.40	−0.23
2007	0.54	0.87	2.17	0.50	2.87	1.75	2.04	0.26	−0.11
2008	0.06	0.11	0.79	0.03	1.22	0.64	0.14	0.28	−0.05
2009	−0.24	−0.17	−0.01	−0.02	−0.01	−0.01	−0.07	0.07	0.03
2010	−0.25	−0.14	−0.12	−0.04	−0.16	−0.10	−0.15	0.03	0.06

Table 5.3: High spillover effects: SPD terminated after 2006

Date	GDPM /g	L /g	GECSFRAE /l	GECSFRAP /l	KGINFR /p	KTRNR /p
2003			0.00	0.00	0.00	0.00
2004	7.81	0.10	1.00	1.31	0.92	0.44
2005	4.72	−0.18	1.22	1.62	2.05	0.98
2006	4.55	−0.32	1.43	1.90	3.34	1.59
2007	4.65	−0.25	0.00	0.00	3.11	1.51
2008	4.79	−0.17	0.00	0.00	2.92	1.44
2009	4.96	−0.07	0.00	0.00	2.76	1.36
2010	5.14	0.03	0.00	0.00	2.62	1.30

Date	GDPM /p	L /p	L /d	LPROD /p
2003	0.00	0.00	0.00	0.00
2004	1.38	1.07	6.31	0.25
2005	2.00	1.44	8.47	0.46
2006	2.73	1.85	10.85	0.73
2007	0.83	0.29	1.69	0.49
2008	0.75	0.24	1.39	0.49
2009	0.60	0.16	0.92	0.45
2010	0.59	0.16	0.91	0.44

Date	OT /p	LT /p	LT /d	LPRT /p	ON /p	LLN /p	LLN /d	LPRN /p
2003	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2004	1.37	1.27	1.77	0.11	1.44	1.44	4.15	0.00
2005	2.14	1.79	2.51	0.34	2.05	1.90	5.47	0.14
2006	3.37	2.62	3.67	0.73	2.67	2.31	6.61	0.35
2007	1.83	1.00	1.40	0.82	0.60	0.10	0.29	0.50
2008	2.12	1.19	1.66	0.93	0.41	−0.10	−0.27	0.51
2009	1.90	1.03	1.44	0.87	0.28	−0.19	−0.53	0.47
2010	1.83	0.99	1.40	0.83	0.27	−0.17	−0.49	0.44

Date	CONS /p	I /p	PGDPFC /p	POT /p	PON /p	PCONS /p	WT /p	NTSVR /d	GBORR /d
2003	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2004	1.78	4.86	0.49	0.29	0.43	0.39	1.26	−1.05	−0.10
2005	2.68	6.61	1.65	0.67	1.79	1.33	3.06	−1.30	−0.18
2006	3.68	8.35	2.72	0.87	3.21	2.19	4.29	−1.35	−0.30
2007	1.19	1.42	2.59	0.56	3.36	2.08	3.09	0.32	−0.21
2008	0.88	0.80	1.34	0.12	1.89	1.08	1.41	0.36	−0.17
2009	0.59	0.55	0.61	0.09	0.77	0.49	1.21	0.16	−0.10
2010	0.56	0.55	0.49	0.06	0.63	0.40	1.09	0.14	−0.06

Annex 2 to Section 5: Simulation Results for Actual SPD 2004-05

In this simulation, the actual SPD financial data for the years 2004 and 2005 are used. The notation is the same as for Annex 1. In light of the very short period (two years), and the limited draw-down of the planned funding, only the medium-case spill-over elasticities is used.

Table 5.4: Medium spill-over effects: Actual expenditure, SPD terminated after 2006

Date	GDPM /g	L /g	GECSFRAE /l	GECSFRAP /l	KGINFR /p	KTRNR /p
2003			0.00	0.00	0.00	0.00
2004	7.81	0.10	0.17	0.24	0.14	0.02
2005	4.72	-0.18	0.62	0.83	0.79	0.22
2006	4.55	-0.32	0.00	0.00	0.73	0.21
2007	4.65	-0.25	0.00	0.00	0.68	0.20
2008	4.79	-0.17	0.00	0.00	0.64	0.19
2009	4.96	-0.07	0.00	0.00	0.61	0.18
2010	5.14	0.03	0.00	0.00	0.59	0.17

Date	GDPM /p	L /p	L /d	LPROD /p
2003	0.00	0.00	0.00	0.00
2004	0.22	0.18	1.06	0.03
2005	0.89	0.68	4.02	0.18
2006	0.13	0.03	0.20	0.08
2007	0.08	0.01	0.08	0.06
2008	0.03	-0.02	-0.13	0.06
2009	0.03	-0.02	-0.12	0.06
2010	0.03	-0.02	-0.12	0.06

Date	OT /p	LT /p	LT /d	LPRT /p	ON /p	LLN /p	LLN /d	LPRN /p
2003	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2004	0.24	0.23	0.32	0.01	0.25	0.25	0.72	0.00
2005	0.90	0.82	1.15	0.08	0.97	0.94	2.69	0.03
2006	0.15	0.07	0.10	0.08	0.13	0.04	0.10	0.09
2007	0.19	0.12	0.16	0.08	0.05	-0.03	-0.08	0.08
2008	0.17	0.08	0.12	0.09	0.00	-0.09	-0.25	0.09
2009	0.17	0.08	0.12	0.08	0.00	-0.08	-0.24	0.09
2010	0.16	0.08	0.11	0.08	0.00	-0.08	-0.23	0.08

Date	CONS /p	I /p	PGDPFC /p	POT /p	PON /p	PCONS /p	WT /p	NTSVR /d	GBORR /d
2003	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2004	0.24	1.00	0.08	0.05	0.07	0.06	0.21	-0.20	0.00
2005	1.11	3.35	0.47	0.23	0.47	0.38	1.01	-0.69	-0.05
2006	0.24	0.35	0.70	0.19	0.88	0.57	0.85	0.05	-0.03
2007	0.12	0.10	0.32	0.01	0.48	0.25	0.12	0.10	-0.03
2008	0.01	-0.02	0.01	0.00	0.01	0.01	0.07	0.02	0.00
2009	0.01	0.00	-0.03	-0.01	-0.04	-0.03	0.03	0.01	0.01
2010	0.00	0.00	-0.05	-0.01	-0.07	-0.04	0.03	0.01	0.01

[6] Convergence and cohesion: sensitivity analysis

6.1 Introductory remarks

The key objective of the *SPD* interventions is to boost the supply-side capacity of the beneficiary economies. Earlier we described how we attempt to model this process by incorporating output and factor productivity externalities into the system of model equations. These externality mechanisms serve to link the *SPD* interventions directly with the supply-side performance of the economy.

If we could base our choice of externality elasticities firmly on local research, then we could propose specific elasticity values that were appropriate to the conditions in each specific country, and which could be incorporated into specific models. Unfortunately we do not have access to such research findings for the new member states. Indeed, in all of our previous research carried out on evaluation of Structural Funds, we have been unable to access any research of a microeconomic nature that would help guide us in our selection of infrastructural and human capital elasticities for these countries (see Bradley *et al*, 2005 for a survey of micro evaluation research). Consequently, we are forced to fall back on the international literature, and make use of findings in a range of countries and regions that have similarities with Estonia.

The international empirical literature, although vast, is somewhat ambiguous about the appropriate magnitude of the externalities, especially for those on the role of human capital. Different researchers use different methodologies, and arrive at different conclusions.[36] Faced with this situation, there are two possible strategies. The first would be to wait until the research results are available in the new member states, and to stand aside from any attempt to quantify the likely macroeconomic impacts of the *SPD* interventions. The second would be to carry out the macroeconomic evaluation exercises with a range of externality elasticities, that are in a plausible range, and to exercise judgement on the most appropriate values for each country based on a wide range of information about the situation in each country.

For example, in the case of the earlier Irish CSFs, there is a body of evidence that suggests that the ESF training schemes – as implemented by the Irish State Training Agency (FAS), 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 in this case. In the case of the Italian *Mezzogiorno* and the Greek CSFs of the 1990s, the limited information that we have on the extensive re-phasing (or "re-programming") of CSF 94-99 that was carried out, might suggest that difficulties may have arisen at the design and implementation stages of many of the Italian and Greek Operational Programmes. This might suggest that lower values for the externality elasticities should be used.[37] In both extreme cases, a sensitivity analysis needs to be carried out to explore how the SPD impact changes as the two types of externalities – with respect to physical infrastructure

[36] For example, in the case of research on the influence of human capital, see the recent Institute of Fiscal Studies review by Sianesi and Van Reenen (2002).

[37] The use of low externality elasticities for the macroeconomic impact analysis is quite consistent with the existence of some highly effective Operational Programmes within an overall CSF. However, in the aggregate, the "re-programming" effects are very likely to hide the beneficial effects of the better programmes, so overall the low elasticities are probably appropriate.

and with respect to human capital - are varied from low to high values. For this exercise, the numbers shown in table 6.1 have been used.

Table 6.1: **Elasticities used in Estonian simulation runs**

		Factor productivity elasticities		
		0.00	**0.10**	**0.20 (T) and 0.10 (N)**
Output elasticities	**0.00**	Zero – Zero		
	0.20		Medium – Medium	
	0.40			High - High

It will be recalled that in the simulations reported in Section 5 previously, the "medium-medium" combination was used throughout the analysis, and the differences between the outcomes were a result of the different underlying macroeconomic structures of the economies, as reflected in the HERMIN models. It should also be noted that we leave the other technical assumptions unchanged from those used in section 5:

a) It is assumed that 50 per cent of expenditure on training is in the form of an overhead, covering buildings, equipment, etc.

b) It is assumed that trainees are paid an amount of half the average manufacturing wage while they participate in training courses, and this appears as an income transfer item in the public sector accounts.

c) The trainee/trainer ratio is assumed to be 15:1, and trainers are assumed to be paid the average wage in market services.

6.2: Sensitivity analysis

In the case "zero - zero" elasticities we effectively only have the conventional pure demand-side Keynesian effects. 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 *SPD* interventions are being implemented (i.e., while there are positive expenditure streams of *SPD* financed 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 after the programmes terminate.

In the case of the "medium-medium" combination, the longer-run 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 medium-medium elasticities are in the middle of the observed scale, and are the most likely values, in the absence of very detailed and specific information on the design and implementation plans for the Estonian SPD.

In the case of the "high-high" combination, the longer-run supply-side effects on output increase to twice the size of the Medium case, and become very important over time as the stocks of physical infrastructure and human capital build up. Compared to the findings taken from the empirical literature, our high output elasticities sometimes fall into the upper end of the observed spectrum of international findings. We set the factor productivity elasticities at 0.20 in the case of manufacturing (a sector that has displayed very high increases in productivity over the past 10 years), but leave them fixed at their Medium values for market services (i.e., 10 per cent), since we are less sure if higher values are appropriate for services.

We have already presented the simulation results for all three cases in Annex S5 above. We summarise the results in Table 6.1 in the case of GDP (GDPM) and total employment (L).

Table 6.1: Estonian Planned SPD 2004-06: zero, medium and high elasticities: Impacts on GDP (GDPM) and total employment (L)

	Zero-Zero case		Medium-Medium case		High-High case	
Date	GDPM	L	GDPM	L	GDPM	L
2003	0.00	0.00	0.00	0.00	0.00	0.00
2004	1.35	1.06	1.36	1.06	1.38	1.07
2005	1.84	1.40	1.91	1.38	2.00	1.44
2006	2.30	1.73	2.49	1.70	2.73	1.85
2007	0.25	0.11	0.50	0.08	0.83	0.29
2008	0.03	0.01	0.33	-0.02	0.75	0.24
2009	-0.11	-0.07	0.19	-0.10	0.60	0.16
2010	-0.11	-0.07	0.18	-0.09	0.59	0.16

Note: In all cases percentage deviations from the no-SPD baseline are shown

The case of Estonia is illustrative of the type of rapid growth that can occur if the structure of the economy is oriented towards competitive growth and active participation in the Single European Market (see ESRI, 1997 for background to this point). The "zero-zero" impacts are the multiplier impacts that tend to accompany investment shocks that are directed mainly at construction and training schemes, i.e., shocks that have rather low leakages out of the economy. But after the termination of the programmes in 2006, the benefits decline rapidly to near zero by 2010.

Moving from "zero-zero" to "medium-medium" and eventually to "high-medium" combinations produces significant and increasingly large boosts to the level of GDP. Also, since the higher "stocks" of infrastructure and human capital continue to generate benefits after the programmes cease in 2006, the higher level of GDP is sustained beyond the implementation years. However, even medium factor productivity spillover elasticities imply productivity growth. For the "medium-medium" case, the change in the employment level by 2020 is effectively zero, since the Medium spillover output effect has not generated enough sustained increase in output (and knock-on demand for labour) to offset the productivity rise. In the "high-high" scenario, modest increases in the level of employment endure since it is sustained by the higher output spillover.

6.3 Conclusions

It would be possible to extend Table 6.1 to include many other options (e.g., of the "high-low" and "high-high" variety). But we have little indication from the literature that such options are relevant. But a much more important issue concerns the optimum balance between investment in physical infrastructure and human resources. This deserves detailed investigation, but we have been unable to find anything of substance in the international literature. It should be stressed that we implement the externality mechanisms for physical infrastructure and human capital in HERMIN as two separate and unrelated processes. In theory, we could set the level of either of these two investment expenditures at any values (including zero), and examine the impact of the "reconfigured" *SPD* programmes on the economy. But there are a number of objections to this approach.

It takes at least two factors of production to generate output in the HERMIN model. If it were possible to construct more sophisticated production functions, using more than two factor inputs, the literature shows that some factors can act as "complements" to others in production, an others can act as "substitutes". So, it is quite possible that physical infrastructure and trained labour could be complements, and the joint improvement of both would be an optimal strategy.

As an example of this process, a feature of Irish industrial development points to the importance of the massive increase in the inflow of mainly US foreign direct investment, most of it in high technology areas. The characteristics of the global technology boom of the 1990s are well known, and Ireland was uniquely positioned to reap the benefits in terms of a massive increase in mainly US foreign direct investment. This was in part a spin-off benefit of the Structural Funds, making use of the improved infrastructure and human capital that had been facilitated by the CSF 1989-93 and CSF 1994-99 Structural Fund programmes.

Consequently, we feel that it would be misleading to present HERMIN-based simulation results where the funding allocations as between physical infrastructure, human resources and direct aid to the productive sectors were varied, without subjecting the analysis to further investigation in terms of the needs of the Estonian economy. In addition to criticisms based on the analysis of the "standard" *SPD* programme allocations, there would be a wide range of other criticisms that would invalidate any policy conclusions reached on the basis of such crude simulations.

But the obvious interest in the quest for an "optimal" allocation of funds across the three main economic categories suggests that one should focus attention of trying to define a more accurate baseline level of the stocks of infrastructure and human capital. The mechanisms used in HERMIN to do this are rather crude, although no cruder than those used in most of the international literature.

[7] Summary and conclusions

We have analysed the impacts of *SPD* 2004-2006 public investment programmes for Estonia, some of which has already been implemented during the period 2004-2005. We saw that over the course of *SPD* implementation the actual expenditures can differ significantly from the planned expenditures, as well as from the planned financial allocations, mainly with respect to timing.

Even with complete *ex-post* or realised *SPD* expenditure tables, it is not completely clear how these financial allocations are related to the actual programme implementation on the ground. This is an important point, since in our *SPD* impact analysis we make the crucial assumption that the financial flows of *SPD* funding are very closely related to the actual real investment activity. In effect we assume that they are the same thing. If there is a lag between financial flows and actual real activity, then our results may be inaccurate on timing, but are probably still correct in the longer term.

The model simulations have already been described and interpreted. But it is worth highlighting some issues in the results. During the implementation of the *SPD,* the increased public expenditures generate modest Keynesian (or demand-side) multiplier effects. Even so, within the HERMIN model, these transient multiplier effects tend to be larger than those in models such as the Commission's QUEST. This is mainly due to the fact that HERMIN uses static or backward-looking expectation mechanisms, while QUEST uses model consistent or forward-looking expectation mechanisms. In addition, the HERMIN models make a clear distinction between public investment in building and construction activities (which have small import propensities) and investment in machinery and equipment (which tend to have very high import propensities, particularly in small open economies like Estonia and several of the smaller new member states.

These transient demand-side impacts of the *SPD* are welcome, i.e., the impacts that accompany the implementation stage, but it is the longer term enduring impacts that are most important. These have been captured by the externality mechanisms that are described in Section 4, and are driven by the *SPD*-induced increase in the stock of physical infrastructure and human capital. We have described how we selected externality elasticities from the international literature and implemented then in the HERMIN models. In Section 5 we used a standard set of elasticities that are broadly representative of the mid range of international findings. In Section 6 we carried out a sensitivity analysis, selecting zero, medium and high elasticity values.

It is important when our numerical results are interpreted that it is understood that the *SPD* in the HERMIN models cannot raise the growth rate of GDP permanently. While the *SPD* investment expenditures are being made, and the stocks of physical infrastructure and human capital are increasing, the growth rate of GDP does indeed increase above the no-*SPD* baseline value. However, when the *SPD* terminates, the two stocks stabilize at their new (higher) values, the growth rate returns to its baseline value, but the level of GDP is at a higher value. Thus, the enduring benefit of the *SPD* is a semi-permanent higher level of GDP and not a permanent rise in the growth rate.[38]

[38] The stocks on physical infrastructure and human capital eventually decay due to depreciation. See Sianesi and Van Reenen, 2002, for a discussion of "level" versus "growth rate" impacts of investment in human capital.

In the absence of any permanent increase in the GDP growth rate, the actual impacts of *SPD 2004-2006,* as simulated in the HERMIN models, might appear quite small. But we saw that the "cumulative multiplier was a better measure of *SPD* impacts in the longer term, at least in terms of "value for money". The cumulative multipliers are designed to capture the notion that Structural Fund programmes continue to yield returns in terms of extra GDP even after they have ceased. This is captured by the externality parameters, that serve to drive GDP and productivity through the higher stocks of infrastructure and human capital that the SPD programmes have produced.

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