Analysis of the Impact of Cohesion Policy

A note explaining the HERMIN-based simulations

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prepared by

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Executive Summary

Our investigation covers the Cohesion Policy programme periods from 2000 to 2006 and from 2007 to 2013, together with a post-implementational phase out to the year 2020. Where the "n+2" rule is invoked, the implementation period continues to the year 2015.

The recipient countries and regions that are analysed are the following:

a) The "old" member states Greece, Ireland, Portugal and Spain for the programme period 2000 to 2013;

b) The "old" member state macro regions of East Germany and the *Mezzogiorno* for the programming period 2000 to 2013;

c) The ten new member states who joined in 2004 and have been supported by Cohesion Policy programmes since 2004;

d) Bulgaria and Romania, who joined on January 1st, 2007 and will receive Cohesion Policy funding support for the period 2007 – 2013.

For each of the above countries (with the exception of Malta), a new HERMIN 5-sector model was set-up using the latest available Eurostat/AMECO database as the main source. For Malta, the available national and Eurostat data only permitted the construction of a two-sector HERMIN model. For the macro regions we relied on local data sources, since no full Eurostat/AMECO databases were available.

The response of the recipient economies to the Cohesion Policy interventions can be divided into two fairly discrete time phases. First, an implementational time phase, where mainly demand-side (or absorption) effects are at work. After the termination of the implementational phase, when the Cohesion Policy funding programmes of investment are assumed to terminate, only the supply-side effects remain. During this later phase, the pure structural change effects induced by the Cohesion Policy investments come into play.

The longer term benefits of the Cohesion Policy interventions arise from the enhancement of the stock of physical infrastructure, the quality of human resources, and from some aspects of direct aid to the productive sector. In the case of direct aid to firms, we distinguish between funds used to finance R&D that serve to enhance the R&D stock of the economy, and other (non-R&D), uses, which have only transitory demand-side impacts.

The size of the overall effects of the Cohesion Policy interventions depends on four properties:

a) The internal macro-sectoral structure of the economy, which is captured by the HERMIN macro models;

b) The relative size of the injection of the Cohesion Policy funding (expressed as a percentage of GDP);

c) The specific distribution of the Cohesion Policy investments over the three main economic categories (physical infrastructure, human resources and R&D);

d) The magnitudes of the spillover benefits of enhanced stocks of physical infrastructure, human resources and R&D.

Cohesion Policy interventions are most important for the new member states. The relative size of the funding injections for most new member states is well above 2 percent of their GDP per year. Exceptions are Cyprus and Slovenia, and to a lesser extent, Malta. For the old member states the funding injections for the period 2007-2013 are less important if measured as a percentage of GDP. With Ireland as an exception, the relative size of the funding injection for the old member states (including the macro regions) is around 1 percent of national / regional GDP per year.

The impacts of the Cohesion Policy interventions on the main economic aggregates show a similar pattern for all countries and regions. In particular, the impacts on GDP during the implementational years (prior to 2013 in Case A and prior to 2015 in Case B) are considerably higher than during the post-implementation phase.

It should be stressed that a large impact on GDP or employment does not necessary imply efficient use of the Cohesion Policy funds. To be able to perform cross-country comparisons a "normalised" measure is introduced, the so-called "cumulative multiplier". The higher this measure is, the more likely it is to point to good use of the investment funds. One can divide the range of countries into three groups, based on a ranking by the size of the cumulative multipliers. We leave aside the regional models since they are specific cases and should not be compared to the national models:

a) *High Cumulative Multipliers*: Ireland (4.82); Romania (4.60); Czech Republic (4.38);

b) *Medium Cumulative Multipliers*: Estonia (3.65); Lithuania (3.36); Latvia (2.78); Slovakia (2.62); Greece (2.47); Poland (2.39); Hungary (2.37); Spain (2.40); Cyprus (2.21)

c) *Low Cumulative Multipliers*: Bulgaria (1.87); Slovenia (1.86); Portugal (1.84)

These cumulative multipliers should be interpreted with caution as is explained in the main text. A key assumption made is that all Cohesion Policy programmes will be designed with a similar degree of optimality, i.e., the supply-side medium-term rates of return are all assumed to be in the mid range of the international findings of investment impacts.

In the case of the new member states, a detailed examination of the Cohesion Policy programmes at a micro level would be required before one could reliably assume country-specific rates of return that truly reflected the quality of policy design, and its degree of optimality.

Consequently, the differences in the above cumulative multipliers reflect the inherent macro-sectoral structure of each country, as captured in the HERMIN model.

Since a key goal of Cohesion Policy is to stimulate employment, we illustrated the impacts on employment at two points in time. The aggregate employment-creation impact in the last year of the implementational phase (Case A in 2013) is around 2054 thousand persons. Even seven years after the termination of the policy, the long-run employment effect is around 701 thousand (Case A, in 2020). The means that some substantial positive effect remains.

For the more realistic Case B, where the "n+2" rule is invoked, and the distribution of funding is spread more evenly, the aggregate employment-creation impact in the last year of the implementational phase (Case B, in 2015) is around 1970 thousand persons. Even five years after the termination of the policy, the long-run employment effect is around 719 thousand (Case B, in 2020).

Finally, we examined the impacts of Cohesion Policy investments on the trade balance. The pattern found was that the trade balance deteriorated (relative to the baseline) during implementation, but that after the programmes terminated, the impact on the trade balance turned positive (relative to the baseline). However, this is the effect of the Cohesion Policy programmes treated in isolation from all other supporting policy changes. When placed in a wider policy context, the beneficial impacts on the trade balance have the potential to be much larger.

[1] Introductory remarks

The analysis carried out during this contract examined the impacts of Cohesion Policy investment programmes on the recipient member states designated as Objective 1, during the period from the year 2000 (the start of the previous seven year programme) to the year 2013 (formally the end year of the present programme that started on January 1st, 2007). The models being used are based on the first trial implementations of the new five-sector HERMIN models that will form the components of the COHESION system being developed for DG Regional Policy.[1]

The four "old" member states (OMS) – namely, Greece, Ireland, Portugal and Spain – received aid for the full period 2000-2006. Three of them will continue to receive significant aid for the period 2007-2013, with Ireland only receiving very small amounts of aid and effectively dropping out of the group.

The ten new member states that joined in 2004 have received aid for the three last years of the most recent programme (2004-2006), and will receive aid for the seven year period 2007-2013.

The two most recent members – Bulgaria and Romania, who joined in January 2007 – will receive aid for the seven year period 2007-2013.

Data on the EC contribution to Cohesion Policy funding were provided by DG-Regional Policy and are summarised in Section 2. These data were originally classified into various Operational Programmes (OPs) and Measures within each OP. The first task that we performed was to re-classify the OP/Measure data into the following three main economic categories:

(a) Physical infrastructure (PI)
(b) Human Resources (HR), and
(c) Direct Aid to the Productive Sector (APS)

Within the category "Direct Aid to the Productive Sectors" (APS), we distinguish between the use of funds to finance research and development (R&D) and other uses of such funds. This re-classification into the three main economic categories is required before the HERMIN models can be used for impact analysis, and is an approximation based sometimes on judgement. It should also be stressed that in the subsequent analysis, no account has been taken of any domestic public co-finance or of any private co-finance. Only the EC element of aid is analysed.

The responses of the economies being aided by Cohesion Policy funding to the investment interventions over the period 2000-2013 may usefully be divided into two different time phases. First, there will be the "implementation" years, i.e., the period during which the aided investment programmes are being designed and implemented. After the programme of aid ends, it is assumed that the improved "stock" of physical infrastructure, the improved level of human resources (or "stock" of human capital), and the benefits of previous direct aid to

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[1] For full details, see *The COHESION system of HERMIN country and regional models: description and operating manual*, Report submitted under contract No. 2005 CE 16 0 AT 027 to DG Regional Policy, April 10, 2007. Extracts from this manual are provided in Annex II of this note.

support R&D (i.e., the improved "stock" of R&D) will continue to exert a beneficial influence on the economies. After the implementation phase ends, these influences operate solely on the supply side of the economy, through spillover mechanisms that serve to raise the level of production and the level of factor productivity.

Consequently, during the "implementational" years the impacts on the recipient economies will be made up of two separate elements:

a) A mainly demand-side element, which is driven by the expenditure of the Cohesion Policy funding on programmes of investment projects. This will be manifested mainly in higher investment, higher consumption, and usually a rise in the trade deficit as imports are sucked in, prior to the supply-side improvements that will serve to generate increased net exports.

b) A mainly supply-side impact that arises due to the gradual build-up of "stocks" of infrastructure, human capital and R&D, and the beneficial output and productivity spillovers that will be generated both during and after the Cohesion Policy programmes.

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

In particular, if one confined the Cohesion Policy impact analysis to the implementation period 2000-2013, the two separate effects would be very difficult to disentangle by simply observing the actual economic outturn. First, during the implementational period – 2000-2013 - the gradual build-up of demand-side effects will dominate and the improved supply side responses will tend to be hidden. Second, other non-Cohesion Policy factors would also be influencing the performance of the economies of the recipient states in the past, and will continue to do so in the future (e.g., the Single Market, foreign direct investment, the performance of a country's main trading partners, etc.).

In order to identify the separate supply-side impacts that will continue after the termination of the Cohesion Policy programme, we have to simulate the models out beyond the formal "termination" year, 2013. In this report we continue the simulations out to the year 2020, i.e., seven years after the termination of the current programme. What the model-based analysis shows is that although the implementational (or demand-side) impacts are large, they vanish rapidly after the year 2013.[2] The supply-side impacts, although more modest, endure for many years, due to the spillover benefits of the improved stocks of physical infrastructure, human capital and R&D.

In this note we present results of the impacts of the Cohesion Policy funds on a group of key macroeconomic aggregate variables, such as aggregate GDP, aggregate employment and aggregate productivity. We stress that it is vital that the results are not misinterpreted. In the past, the long-enduring impacts of Cohesion Policy funds on the level of GDP (as generated using the HERMIN models) have sometimes been confused with the more transitory impacts on the growth rate of GDP. Unlike pure growth models, HERMIN examines the impacts on

[2] If the so-called "n+2" rule is invoked, the implementation period continues beyond 2013, out to the year 2015.

the level of GDP. Obviously, the Cohesion Policy investments serve to boost the GDP growth rate temporarily, but it would be unreasonable to build into HERMIN any assumptions that the growth rate would be permanently increased by an isolated programme of investment aid.[3] While the programmes are being implemented, the growth rate moves higher than in the no-Cohesion Policy baseline. When the programmes are terminated, the negative demand shock drives the growth rate lower than in the no-Cohesion Policy baseline. The overall effect is to leave the level of GDP higher than in the baseline, by an amount that varies from country to country. When interpreting the model simulations, it is vital that all impacts be understood to refer to changes relative to a no-policy baseline. In addition, that while impacts on (say) the level of GDP can be long enduring, any impacts on the growth rate of GDP are transitory.

It is not our purpose to provide complete technical details of how the impact results in this note were derived.[4] Briefly, we start with a specially prepared "without-CP" baseline projection. In effect, this is a form of medium- to long-term forecast (or scenario). Such longer-term scenario analysis is not common in any of the recipient states, except Ireland.[5] We then set the Cohesion Policy investment expenditures at the levels described in the DG-Regional Policy data provided to us, as re-classified into three economic categories, and re-simulate a "with-CP" outcome. The "with-CP" simulation is compared with the "without-CP" baseline, and the differences are taken as measures of the Cohesion Policy impacts. These differences are usually expressed as percentage changes relative to the baseline (e.g., for GDP impacts), but can also be expressed as absolute differences from the baseline (e.g., for unemployment numbers, the net trade balance, etc.).

The rest of the note is organised as follows. In Section 2 we summarise the financial dimension of the European CP as they are used in the simulations. In Section 3 we describe some of the key assumptions made in preparing and executing the Cohesion Policy simulations. In Section 4 we present the main impact results, and a wider range of results is made available on a CD-ROM in the form of MS Excel spreadsheet files. In Section 5 we describe the impacts of the Cohesion Policy interventions on trade. Section 6 concludes.

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3 The kind of cumulative and enduring high growth of the kind experienced by Irish economy during the 1990s, as well as the high growth rates of some of the Baltic States, are usually caused by a complex of policies, including industrial policy to encourage clusters, the EU Single Market, convergence towards euro-zone low interest rates, as well as by NDP policies. Indeed, the optimisation of the use of Structural Funds needs to consider the wider development strategy being implemented by a country.

4 See footnote 1 above for a reference to the detailed *User Manual* of the COHESION system of HERMIN models.

5 The ESRI in Dublin has published a formal, model-based, five-year forecast, with an outline ten-year scenario, since the mid-1980s. Such an exercise is presently under way in Poland. No other country publishes forecasts in any detail for more than a couple of years forward.

[2] The European Union's Cohesion Policy 2000 -2013

The Structural Funds and Cohesion Funds are the main budgetary items of the European Union to support economic and social cohesion in the member states. Regional and structural policies are the second largest item in the budget after the common Agricultural Policy and cover more than a third of the budget. They are set-up as multi-annual initiatives and the period from 2000 to 2013 consists of two programming periods, the first running from 2000 to 2006 and the second from 2007 to 2013 (with possible extensions to 2015 under the "n+2" rule).

For the period from 2000 to 2006 more than € 250 billion was allocated to Structural Policies and largely spent during these years on the 15 Member States and the structural interventions in the New Member States, who joined the European Union in 2004. In addition, some proportion of the € 250 billion was used in the pre-accession phase. Table 2.1 shows how the Structural Funds and Cohesion Funds are distributed to the Member States under objective-1 and the cohesion priority. The main recipients for the full period are Spain, Portugal, Italy and Greece followed by East Germany and Ireland. Since 2004 the New Member States are also supported as Objective-1 areas. The main recipients are Poland followed by Hungary and the Czech Republic. Up to 2006 the annual figures indicate actual payments, for the years 2007 and 2008 the unspent remainder was equally distributed. As can be seen, around 30 % of the financial aid is allocated to these two years.

For the period from 2007 to 2013 a new set of Structural programmes has been designed and the Member States prepare on that basis their Operational Programmes, respectively. The total budget for the actual period is around € 308 billion (in 2004 prices). Around 85 % of this total budget is concentrated on Member States and Macro-regions who are supported under the new "convergence"-objective and the cohesion priority. The remainder is distributed to a new "regional competitiveness and employment" objective and a "European cooperation" objective to enhance cross-border cooperation. An indicative allocation of the Funds to the Member States was delivered by DG Regional Policy and is shown in Table 2.2. It is the first time that the New Member States receive Funds for the full period, so that it is now possible to compare them with the "Old" Member States. As can be seen, Poland is now the main recipient country followed by Spain, the Czech Republic and Hungary. Portugal, Greece, Italy and Romania follow. The distribution of the Funds shifted largely to the New Member States that are the economies that are most lagging behind in the European Union. The reported payment profile of Table 2.2 is preliminary. The experience during former programming periods has shown that delays in decision on Operational Programmes and problems during the implementational phase have led to quite different actual payment schemes. This has to be taken into account when simulations are performed.

Table 2.1: Cohesion Policy interventions 2000 – 2006 by Member State in mill. Euro, current prices

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Poland					911.0	815.0	1781.0	3776.5	3776.5	**11060.0**
Czech					208.0	186.0	462.0	743.0	743.0	**2342.0**
Cyprus					5.0	8.2	13.7	38.6	38.6	**104.0**
Estonia					54.6	76.6	139.3	171.8	171.8	**614.0**
Greece		1943.0	1358.0	1229.0	2247.0	2090.0	3021.0	5506.5	5506.5	**22901.0**
Spain	149.0	4550.0	7085.0	7077.0	7049.0	6380.0	4303.0	7431.5	7431.5	**51456.0**
Ireland	194.0	450.0	599.0	536.0	491.0	380.0	350.0	264.0	264.0	**3528.0**
Italy	1089.0	214.0	1146.0	2333.0	2188.0	2478.0	2807.0	4051.5	4051.5	**20358.0**
Latvia					74.0	126.0	145.0	351.5	351.5	**1048.0**
Lithuania					94.0	173.0	187.0	452.0	452.0	**1358.0**
Hungary					204.0	356.0	595.0	827.5	827.5	**2810.0**
Malta					6.0	4.4	14.6	26.5	26.5	**78.0**
Portugal	1176.0	1576.0	2533.0	2772.0	2773.0	2391.0	2090.0	2991.5	2991.5	**21294.0**
Slovenia								122.4	122.4	**244.7**
Slovakia								485.0	485.0	**970.0**
Eastern Germany	518.0	1940.0	2077.0	1928.0	2316.0	2551.0	2359.0	2175.5	2175.5	**18040.0**
Total	**3126.0**	**10673.0**	**14798.0**	**15875.0**	**18620.6**	**18015.2**	**18267.6**	**29415.2**	**29415.2**	**158205.7**

Source: DG Regional Policy (2007)

Table 2.2: Planned Cohesion Policy interventions 2007 – 2013 by member state in Mil. Euro. 2004 prices

Country	2007	2008	2009	2010	2011	2012	2013	Total
Poland	7680.0	8024.9	8365.9	8405.0	8747.9	9073.7	9401.1	**59698.6**
Czech	3136.0	3222.9	3305.9	3391.2	3472.0	3547.7	3621.6	**23697.2**
Cyprus	158.2	128.9	99.7	70.4	41.2	41.2	41.2	**580.8**
Estonia	355.7	379.7	405.4	432.8	462.6	494.4	527.5	**3058.1**
Greece	2914.8	2803.8	2692.9	2582.0	2471.2	2407.9	2344.6	**18217.2**
Spain	5947.0	5329.7	4712.8	4196.2	3879.6	3783.5	3687.4	**31536.3**
Ireland	199.9	167.4	134.9	102.4	69.9	70.0	70.1	**814.5**
Italy	2774.0	2869.0	2753.0	2744.0	2690.0	2724.0	2714.0	**19268.0**
Latvia	480.0	513.0	549.0	584.0	619.0	655.0	691.0	**4091.0**
Lithuania	725.3	771.5	819.6	867.8	918.3	971.5	1023.0	**6097.0**
Hungary	2868.0	2990.9	3121.4	3227.4	3302.7	3414.4	3526.6	**22451.5**
Malta	108.1	108.5	108.8	109.1	109.2	108.8	108.3	**760.8**
Portugal	2807.2	2783.1	2759.2	2735.3	2711.4	2687.4	2663.4	**19146.9**
Slovenia	523.9	527.3	530.7	534.1	537.5	540.9	544.3	**3738.7**
Slovakia	1227.9	1303.3	1385.7	1479.7	1558.0	1631.5	1678.2	**10264.3**
East Germany	2310.0	2264.0	2234.0	2196.0	2157.0	2118.0	2079.0	**15358.0**
Bulgaria	486.0	682.9	900.6	929.4	974.0	1016.9	1057.5	**6047.3**
Romania	1261.2	1774.2	2339.3	2752.5	2906.6	3063.4	3219.4	**17316.6**
Total	**35963.2**	**36645.1**	**37218.5**	**37339.5**	**37628.1**	**38350.3**	**38998.2**	**262142.9**

Source: DG Regional Policy (2007)

[3] Technical assumptions made in the simulations

The models used in the impact analysis were the preliminary versions of the HERMIN models of the new COHESION system being prepared for internal use internally by DG-Regional Policy. Full technical details of these models, and the computer system that has been designed to operate them for the analysis of Cohesion Policy impacts, are available in *The COHESION system of HERMIN country and regional models: description and operating manual*, Report submitted under contract No. 2005 CE 16 0 AT 027 to DG Regional Policy, April 10, 2007. An extract from this manual is provided in Annex II to this note.

We retained most of the basic assumptions that were made in many previous ex-ante impact analysis of Structural Funds and Cohesion Funds (referred to in this note as "Cohesion Policy"). The most important assumption – insofar as it affects the impact outturn – concerns the so-called spillover parameters. These are designed to capture the benefits of the improved stocks of physical infrastructure, human capital and R&D in boosting output and productivity during the implementation stage and after the SF programme ends in 2013.[6]

On the basis of our examination of the international literature, and after reviewing some of the member state NSRF background documents, we have assumed the following "spillover" elasticities as fairly conservative initial working hypotheses.[7]

	Manufacturing output	**Manufacturing productivity**	**Market Services output**	**Market Services productivity**
Physical infrastructure	**0.20**	**0.10**	**0.03**	**0.03**
Human resources	**0.10**	**0.10**	**0.03**	**0.03**
R&D (APS)	**0.03**	**0.03**	**0.03**	**No spillover effect**

What this means is that – for example – a 1 per cent increase in the level of the stock of physical infrastructure financed through Cohesion Policy will induce a long-run increase of 0.2 per cent in manufacturing output, 0.1 per cent in manufacturing productivity, 0.03 per cent in the output of market services and 0.03 per cent in the level of productivity in market services. Note that we take a rather pessimistic approach to the role of spillovers in market services (compared to manufacturing), as well as a conservative approach to the role of R&D in creating spillover benefits. This latter view may change as more information about the nature of the R&D programmes becomes available.[8] All other technical assumptions are unchanged from previous studies, e.g., trainee/instructor ratios, training scheme overheads, etc.

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6 See Annex 1, sections 2 and 4, for technical details of the international literature and the implications for the selection of spillover parameter values.

7 The case of Malta is different, since it was only possible (at great difficulty) to construct a two-sector HERMIN-type model for that country: a private sector and a public sector. The private sector combines manufacturing, market services and agriculture (as defined in the five-sector HERMIN models). Average values for the spillover elasticities (as between manufacturing and market services and shown in the above table) were used.

8 Most of the empirical research on the impacts of R&D are based on US studies, and may be a poor guide to possible impacts in the relatively under-developed new member states of the EU. We took this on board by imposing lower values of the spillover elasticities.

The simulations were carried out in the following two-stages. First, an effort was made to obtain a "reasonable" baseline projection for each country model out to the year 2020. For the period 2000-2005, this was close to the actual outturn as recorded in the AMECO/EUROSTAT data.[9] All the Cohesion Policy instrument variables were set to zero in the baseline (no-CP) simulation. Hence, this simulation represents what might happen if no Cohesion Policy Funding was forthcoming, and no counterpart domestic investment programme was implemented instead.[10]

Next, the Cohesion Policy data were set at the values derived from the data supplied by DG-Regional Policy (i.e., investment in physical infrastructure (henceforth, PI), human resources (henceforth, HR) and direct aid to the productive sectors (henceforth, APS). In addition, we set the fraction of APS that was devoted to investment in R&D. Using the technical assumptions for the so-called "spillover" elasticities (mentioned above), we then simulated the models again, and obtained the outturn for the "with-CP" case.

Finally, the comparison of the "with-CP" case and the "without-CP" case permits the derivation of the impact of Cohesion Policy on any of the endogenous variables in the model. In practice, only a limited number of key variables are examined initially (GDP, employment, productivity, investment, consumption, etc.). These are presented in separate XLS files (attached to this report as a CD-ROM), whose structure is fully described in Annex I below.

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9 In the case of Bulgaria, the AMECO/EUROSTAT sources are very deficient. The national data team could only produce data to the year 2004. It should be noted that the AMECO database for the year 2005 sometimes represents a partial set, that has been augmented from local sources by the modelling team. As previously noted, in the case of Malta the data were inadequate for construction of a HERMIN model, and that country was the subject of a special analysis based on a reduced form, two-sector HERMIN-type model.

10 See Annex III for a PowerPoint exposition of the nature of this and other possible counterfactuals. Using the terminology of Annex III, in this note we are assuming a "zero substitution" counterfactual.

[4] Overview of main results

We present our results in two different ways. First, in this note we give an overview of the main findings, summarised in the set of 14 tables presented in Annex I. Second, we have supplied a separate set of XLS spreadsheet files that present the simulation results in much greater detail. However, if greater detail is needed – for example, sectoral detail – these can be provided on request. In effect, it is possible to supply the Cohesion Policy impacts on all the endogenous variables in any HERMIN model (of which there are some 300). However, not all these impacts would be interesting.

We were provided with four main different sets of Cohesion Policy implementations, and asked to handle them separately. In the attached Annex I we present the two main implementations, referred to as CASE A and CASE B. In the separately supplied MS Excel spreadsheet files, there are four distinct sets of results: CASES A and B (as in Annex I), plus CASES C and D. These distinctions were requested by DG Regional Policy and are explained as follows. CASE A terminates the Cohesion Policy funding in the year 2013, and has an annual expenditure profile that uses up all the funds by that year. CASE B invokes the so-called "n+2" rule, and continues the funding out to the year 2015. Consequently, the annual expenditure profile in CASE A is more "bunched" than in CASE B, since CASE A is implemented over two fewer years. The first seven tables in the Annex present the tables for CASE A and the following set of seven tables present CASE B.

CASES C and D are only supplied as separate MS Excel spreadsheet files, and are defined as follows. CASE C has a similar expenditure profile for the period 2000 to 2006 than CASE A, but the expenditure for the period 2007 – 2013 start with some delay in 2010 and invokes the so-called "n+2" rule, and continues the funding out the year 2015. CASE D is a truncated SF scenario, just looking at the impact of the period 2007 – 2013. All SF spendings up to 2006 are set to zero and the spending profile for the period 2007 – 2013 invokes the "n+2-rule" and the observed spending profile for the period 2000 to 2006.

The Tables included in the attached Annex I refer only to CASES A and B, and are as follows:

Tables 1 and 8 present values of the HERMIN variable called GECSFRAE, which is the CP funding injection for each year expressed as a percentage of the level of GDP for that year. Note that as GDP grows over time – both due to the CP impacts and for other reasons – the GECSFRAE measure will drift below the ex-ante measure derived using the GDP for the year prior to CP implementation. Obviously, GECSFRAE reverts to zero after the end of the programme in the year 2014 (for CASE A) and in 2016 (CASE B).

Tables 2 and 9 are derived from Tables 1 and 8, and accumulate the GECSFRAE measures, so that for any given year, Tables 2 and 8 show the cumulative injection of CP funding, expressed as a percentage of GDP. This measure reaches a maximum in the year 2013 (CASE A) and in the year 2015 (CASE B), and remains stable thereafter.

Tables 3 and 10 show the annual impact on GDP due to the SFs, expressed as a percentage increase from the no-CP baseline. During the so-called "implementational" years, this measure tends to be dominated by demand-side (or Keynesian) mechanisms. After the CP programmes cease in 2013 (CASE A) and in 2015 (CASE B), the withdrawal of funds causes the Keynesian impact to go to zero, leaving the longer term supply-side impacts due to improved stocks of infrastructure, human capital and R&D.

Tables 4 and 11 are derived from Tables 3 and 10, and show the cumulative impact on GDP due to the CP investment programmes, expressed as a percentage increase from the no-CP baseline. During the so-called "implementational" years, this measure tends to be dominated by demand-side (or Keynesian) mechanisms. However, unlike Tables 2 and 9 (the cumulative CP injections), the cumulative impact on GDP continues to rise after 2013 (in CASE A) and after 2015 (in CASE B), since the economies will continue to benefit from positive spillovers obtained from improved stocks of PI, HR and R&D.[11]

Tables 5 and 12 show the so-called "cumulative CP multiplier", which is calculated by dividing the cumulative percentage increase in the level of GDP by the cumulative injection of CP funds (the latter expressed as a share of GDP). This multiplier serves to "normalise" the results (i.e., make them relatively independent of the size of the CP injection). Hence, the cumulative multipliers can be compared from country to country. In effect, the cumulative multiplier represents a measure of "rate of return" on CP funding.

Tables 6 and 13 present values for the year 2013 (CASE A) and 2015 (CASE B) of two key variables. First, for total GDP at constant market prices (GDPM, in HERMIN notation), expressed as a percentage deviation from the baseline. Second, for total numbers employed (L, in HERMIN notation), expressed both as the change in employment relative to the no-CP baseline (in thousands) and as the percentage change of L relative to the no-CP baseline. The values shown can be seen as the impact of the Cohesion Policy investments in the last year of the implementation (2013 in CASE A; 2015 in CASE B).

Tables 7 and 14 present the same variables as in Tables 6 and 13 above, but this time both for the same year, 2020. The values shown can be seen as the long-run yearly impact of the Cohesion Policy investments, that can be expected even seven years (CASE A) or five years (CASE B) after the Structural Fund interventions have terminated.[12]

We now examine this sequence of seven summary Tables 1-7 for CASE A under a series of headings, and describe the main findings. Similar interpretations (with obvious modifications for the different phasing of the CP interventions) can be given for CASE B, Tables 8-14.

4.1 The annual size of the Cohesion Policy injections

An obvious observation to make is that the CP impact on (say) GDP is likely to be closely related to the size of the injection of CP funding, measured as a percentage of GDP. Small injections of CP funding (measured as a percentage of GDP) are likely to produce small impacts on GDP, unless very special circumstances prevail.

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[11] Obviously, the stocks of PI, HR and R&D will "decay" over time, in the absence of further investment. Decay rates are applied, but are fairly low. So, the spillover benefits are sustained into the longer term.

[12] Note the important assumption that no other CP programme takes over when the present one terminates. Nor do we assume that a purely domestically-funded programme will be substituted. Once again, the Irish case is instructive, since the recently published NDP 2007-2013 is almost entirely domestically funded. Consequently, our simulations are somewhat artificial. This should be taken into consideration when one tries to relate the model simulations to the situation that will be likely to prevail after 2013/2015. It is not always the HERMIN model that is unrealistic! See Annex III for further observations on different counterfactual possibilities.

What Table 1 shows is that the CP injections into the old member states (OMS) – Greece, Portugal and Spain) are relatively small, when expressed as a percentage of GDP. The Irish values are the lowest of the four OMS (peaking at 0.46 per cent of GDP in 2002). In the case of Spain, they range between 0.02 per cent to a maximum of 1.24 per cent. The Portuguese and Greek injections are still larger, and peak at 3.49 per cent of GDP (Portugal, 2007) and at 3.79 (Greece, 2007). However, during the 2007-2013 period, the Portuguese and Greek injections are much lower, at between 1 and 1.5 per cent of GDP.

The CP injections for the ten new member states entering the EU in 2004 build up from low levels after 2004 and are in the region of 3 per cent of GDP by the end of the programming period. However, there are exceptions. Cyprus – a relatively wealthy country – has a low injection (peaking at 1.41 per cent of GDP in 2007, and declining to 0.28 per cent of GDP in 2013). Slovenia – another relatively wealthy country – also has a low injection (peaking at 2.13 per cent of GDP in 2007, and declining to 1.50 per cent by 2013). In the case of Malta, the injection peaks at 2.69 per cent of GDP in the year 2007, and remains at about 2 per cent of GDP.[13]

A final observation on this point is that the size of the CP injection, expressed as a percentage of ex-post GDP, will be influenced by the pattern of growth of GDP both in the baseline (without-CP) simulation and due to the CP impacts themselves. The Bulgarian share seems rather high, perhaps due in part to the fact that the underlying growth rate in the baseline is rather low. This could be examined further, but the data problems for Bulgaria make forecasting particularly difficult. The derivation of realistic and authoritative baseline forecasts out to 2013 is a complex and daunting task. Presumably the original allocation of Cohesion Policy funding was carried out using shares of GDP for years prior to 2006.

4.2 The cumulative size of the CP injections as a share of GDP

Turning to Table 2, we see the different patterns of the cumulative injections of Cohesion Policy funding, where these are also expressed as a percentage of GDP. These range from the low values for Ireland (2.93) and for Spain (9.03). For Greece the cumulative peak by 2013 is 20.2 per cent of GDP), and for Portugal the peak is 25.33 per cent of GDP.

Eight of the ten NMS have broadly similar cumulative injections, in the range of 20 to 25 per cent of GDP. Cyprus, Slovenia and Malta are the exceptions, with values of 4.8, 12.7, and 16.4 per cent of GDP, respectively.

The size of the CP injection, cumulated in this way, gives an idea of the size of the shock to the economy. If Cohesion Policy had no supply-side spillover impacts, then we would be able to predict the impact on GDP once we knew the size of the so-called Keynesian multiplier. For the smaller, more open EU member states, this would be usually in the region of unity. In other words, if Cohesion Policy funding were to be devoted to digging useless holes in the ground, and filling them in again (to use Keynes' example), then the impact on the economy would at best be about equal to the size of the CP injection. After the programme ended, there would be no sustained benefits, and the level of GDP would revert to

[13] The long-term baseline growth forecast for Malta was very difficult to prepare, and is relatively low. This may serve to push up the SF share of GDP.

its baseline value. If the economy were already operating at near full capacity, there would be severe crowding out.

But even if the Cohesion Policy funds are used to fund wise and productive investments, it is not the absolute size of the CP injection, expressed in millions of euro that matters. Rather it is the size of the CP injection relative to the size of the recipient economy. The broadest measure of economic size is GDP. Other things being equal, we would expect bigger CP injections (expressed as a share of GDP) to have bigger impacts. As we will see, the models broadly confirm this, but also illustrate how the structure and dynamism of the recipient economies can heavily influence the final outturn. For example, if an economy has a relatively small and unproductive manufacturing sector, and is not export oriented, the CP impacts are likely to be smaller than in the case of an economy with a dynamic, export-oriented manufacturing sector. The full range of structural features of economies – as captured in the HERMIN models – is rather technical, and cannot be comprehensively described in this short note.[14]

4.3. The pattern of annual CP impacts on the level of GDP

Table 3 shows the impact on GDP of the Cohesion Policy investments, expressed in terms of the percentage change in the level of GDP relative to the no-CP baseline value of the level of GDP. A common pattern can be seen. The impacts on GDP during the implementational years (prior to 2013 in the present CASE A) are considerable higher than the post-implementational impacts.

It should be stressed that a large impact on GDP does not necessarily imply efficient and/or effective use of the Cohesion Policy funds. It might just arise from a large injection of funds, expressed as a share of GDP. Similarly, a small impact on GDP might just imply a correspondingly small injection of funds (e.g., the case of Ireland). Cross-country comparisons require us to develop a “normalised” measure of the impact, and this will be the cumulative multiplier in Table 5. We postpone comparisons until then.

4.4 The pattern of cumulative CP impacts on the level of GDP

We now turn to Table 4, which shows the impacts of the Cohesion Policy investments on the cumulated percentage rise in the level of GDP. As explained in the previous point, these results cannot be compared between countries, nor can any inference be drawn that the larger impacts denote more efficient use of Cohesion Policy. Nevertheless, the individual results are interesting. Table 4 shows that the cumulative increase in the level of GDP associated with Cohesion Policy investments ranges from 10.7 per cent (in the case of Cyprus and 13.7 per cent in the case of Ireland to about 90 per cent in the cases of Estonia, Latvia and Lithuania.

Consider the two cases of Poland and Estonia, where the cumulative increases in the level of GDP by the year 2020 are 59% and 92%, respectively. We can interpret these numbers as follows. Let us assume (for the sake of the exposition) that both Poland and Estonia grow at least as fast as the EU average in their respective no-CP baseline. In fact, based on recent experience, this is an extremely conservative assumption, since both economies have actually

[14] See the COHESION System model *User Manual* for further details (op. cit.)

been growing much faster than the EU average. But if this assumption were true, it would imply that neither Poland nor Estonia would make any progress in catching up with the EU average (i.e., no cohesion progress). In other words, they would remain at roughly the same relative position within the EU in terms of GDP per capita.

One interpretation of Table 4 is that it suggests that the impact of Cohesion Policy over the period 2004-2013 (assuming that it terminates after 2013) would be to raise the cumulative level of GDP by 59 per cent in the case of Poland and by 92 per cent in the case of Estonia, over and above any increases due to growth taking place in the no-CP baseline scenario.

But since we assumed (for sake of exposition) that Poland and Estonia were growing at the EU average in the no-CP baseline, then this extra CP-induced rise in the level of GDP would permit a degree of cohesion (or real convergence) to take place. Spreading the cumulative increase in GDP over the period 2007-2020 (i.e., the seven years of significant CP programmes for 2007-2013, and for the seven year period of zero CP to 2020), then the average sustained increase in the level of GDP over and above the rest of the EU would be about 4.2 per cent for Poland and 6.6 per cent for Estonia. On the basis of the crude assumptions that we made, this would be the number of percentage points of cohesion that would be delivered by Cohesion Policy.

It is very artificial to separate the CP-induced cohesion process from all the other factors that might serve to promote cohesion. But it does give a rough order of magnitude of the modest, but significant role that Cohesion Policy can play in isolation from these other driving forces.

4.5 The emerging pattern of cumulative multipliers

A good way of presenting the CP impact results in a manner that permits cross-country comparisons is to calculate the so-called cumulative CP multiplier. This is defined as the cumulative percentage increase in the level of GDP divided by the cumulative CP funding injection (expressed as a percentage of GDP).[15] These are presented in Table 5 in Annex I. Since the absolute level of CP funding injections shown in Tables 3 and 4 are now replaced by the "normalised" multiplier, one can say that countries with high cumulative multipliers are the ones that are most likely to make best use of Cohesion Policy aid. By "best use" we mean that both the Operational Programmes and the inherent structure of the economies (as reflected in the structure of the HERMIN models), together with any non-CP supportive policies, combine to produce high impacts on the level of GDP (or, equivalently, high transitory impacts on the growth rate of GDP).

This phenomenon is illustrated by the case of Ireland, where the CP injections expressed as a percentage of GDP were low (Tables 1 and 2), but where the cumulative CP multiplier by 2020 (at 4.8) is very high (Table 5).

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15 The ordinary definition of a public expenditure multiplier is the change in the level of GDP (relative to a baseline) divided by the change in public expenditure. This is derived during the testing of the HERMIN models, in order to check the "validity" of the model structure. The size of the public expenditure multiplier is in the region of unity for the smaller states, and rises above unity for the larger, less open economies.

One can divide the range of countries into three groups, based on a ranking by the size of the cumulative CP multipliers:[16]

- *High Cumulative Multipliers*: Ireland (4.82); Romania (4.60); Czech Republic (4.38);

- *Medium Cumulative Multipliers*: Estonia (3.65); Lithuania (3.36); Latvia (2.78); Slovakia (2.62); Greece (2.47); Poland (2.39); Hungary (2.37); Spain (2.40); Cyprus (2.21)

- *Low Cumulative Multipliers*: Bulgaria (1.87); Slovenia (1.86); Portugal (1.84)

4.6 Interpretation of the pattern of cumulative multipliers

In view of the early stage of development and use of the new HERMIN models, as well as the rather poor quality of economic (macro-sectoral) data for some of the new member states, we would advise caution in the interpretation of the above pattern of cumulative CP multipliers. The high value for Romania and the low value for Bulgaria are cases in point. Both economies have undergone very late transitions to market liberalisation, and the quality and reliability of macro-economic data are low. Consequently, it is difficult to regard the HERMIN models for Bulgaria and Romania as being stable, in the sense that the structural patterns of development can be clearly identified and modelled.

It should also be recalled that we have assumed a common pattern of spillover elasticities for all countries. So, for example, we assume that the quality of Cohesion Policy investment planning is the same in Ireland (on the one hand) as it is for Bulgaria (on the other). Clearly this may not be a very realistic assumption. But it is forced on us by the complete absence of any independent evaluation of the capacity of individual recipient countries to plan and optimise their Cohesion Policy Operational Programmes, and to implement the resulting investment projects in a timely and cost-effective manner.

Based on our knowledge of all the new member states, we have formed our own professional opinions of the different standards of administrative capacity of the Cohesion Policy managing authorities, and the quality of the economic analysis that underlies the pre-CP planning. If one acted on this information, one would need to alter the sizes of the so-called spillover elasticities, since these capture the "quality" of the CP investments in terms of their likely rates of return (i.e., their ability to cause faster growth and produce a higher relative level of GDP per head). However, we are reluctant to go down this route prior to there being a detailed examination of the country *National Strategic Reference Frameworks* at a micro-economic level. [17]

Consequently, in the simulation results presented in this note, the differences in the cumulative multipliers are only capturing the inherent "structural" differences between the economies of the recipient member states, as captured in the structural equations of the

[16] We leave aside the regional models since they are specific cases and should not be compared to the national models.

[17] See Bradley, J., T. Mitze, E,. Morgenroth and G. Untiedt (2006), How can we know if EU Cohesion Policy is successful? Integrating micro and macro approaches to the evaluation of Structural Funds, Monograph, GEFRA/Muenster, March, for a description of how micro-analysis of NSRFs can guide one towards the appropriate size of the spillover elasticities.

respective HERMIN models. The role of Cohesion Policy is to change the inherited structure. But a bad inherited structure can slow convergence, particularly when there are rigidities present.

Some examples will serve to illustrate this point. Consider Ireland and Greece. The HERMIN models of these two OMSs capture some important stylised facts and differences between their economies. For example, the CES production functions for manufacturing have rates of technical progress of about 8 per cent per year in the case of Ireland, but only 1.4 per cent per year in the case of Greece. In addition, whereas the Irish economy is extremely open to world trade (as measured by export and import ratios to GDP), whereas the Greek economy is the least open in the EU (based on these measures).[18] In terms of wage bargaining mechanisms, a much high proportion of productivity in passed on to wages in the case of Greece than is the case in Ireland. These are the kind of structural differences that emerge from the HERMIN models, and serve to influence how the models respond to CP-type shocks.

The danger in building models is that one might use past data to calibrate the models in a case where major structural changes come about, that might serve to alter the future response of the economy to policy shocks. This is the so-called Lucas critique, and warns one off using crude, reduced form models, or inflexible structures. It also suggests that one should use as up-to-date data as possible. In the case of the HERMIN models we have used data up to the year 2005, the latest year for which national accounts are available in EUROSTAT/AMECO. In addition, the manner in which the transmission mechanisms for Cohesion Policy are incorporated into the models permits them to alter the structure of the models over time.

4.7 The yearly impacts in 2013 (Case A)

Table 6 shows the situation for CASE A in the year 2013, i.e., when the CP programmes are assumed to end. In CASE A, the year 2013 is the last one before all funding goes to zero. Since it is seven years into the programme (which started in 2007), the impacts are a mixture of demand effects and supply effects. The following Table 7 (showing the situation in the year 2020) is pure supply-side, since all demand/implementational impacts are gone.

By the GDP measure (i.e., the percentage increase in the level of GDP relative to the no-CP baseline), the biggest impacts are in the three Baltic States and the Czech Republic (where the level of GDP is between 9 and 10 percent higher than in the no-CP baseline). If every country received a CP injection that was the same fraction of its GDP, then one might compare these results. But, as noted above, one can only do inter-country comparisons using cumulative multipliers.

Turning to the impacts on employment, expressed as a percentage deviation from the no-CP baseline, one sees that the percentage rise in the level of employment tends to be much smaller than the percentage rise in the level of GDP. In the case of Estonia, these are 9.7% (GDP) and 6.2% (employment), respectively. The model structure drives a "wedge" between output growth and employment growth, due to relative factor price changes (i.e., the price of labour relative to the cost of capital), and technical progress.

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[18] The issue of economic openness is taken up in the next Section.

The third column gives the change in the number of people employed. Of course, the underlying size of the national labour force makes these numbers difficult to compare, unlike the percentage changes.

4.8 The yearly impacts in 2020 (Case A)

Table 7 shows the same two variables as in Table 6, but for the year 2020, i.e., seven years after all Cohesion Policy investment programmes are assumed to cease. Perhaps the most useful summary measure is the sustained increase in total numbers employed in all recipient countries in the year 2020 (700 thousand), compared with 2054 thousand in the year 2013. This is a rather artificial situation, and assumes that as the CP programmes cease in the year 2013 and the workers on all the projects are simply laid off (construction workers, trainers, management consultants, etc.). But even after these layoffs, there are still over 700 thousand extra employed, due to the sustained buoyancy of the economy caused by the supply-side spillovers of improved infrastructure, etc.

Turning to the sustained impacts on the level of GDP, it is clear that this is much lower than the increase that applied in the year 2013. For example, in the Baltic States, the 9 per cent boost in the level of GDP falls to about 4 per cent in the year 2020. This suggests that about one half of the 2013 increase was "demand-side" and one half was "supply-side". However welcome the demand-side boost is, to economies that are working under capacity and have high actual and hidden unemployment, only the supply-side boost is sustainable into the longer term.

4.9 The impact in Case C and D

CASES C and D are supplied as separate MS Excel spreadsheet files, and are defined as follows. CASE C has a similar expenditure profile for the period 2000 to 2006 than CASE A, but the expenditure for the period 2007 – 2013 starts with some delay in 2010 and invokes the so-called "n+2" rule, and continues the funding out the year 2015. CASE D is a truncated CP scenario, just looking at the impact of the period 2007 – 2013. All CP expenditures up to 2006 are set to zero and the spending profile for the period 2007 – 2013 invokes the "n+2-rule" and the observed spending profile for the period 2000 to 2006.

To illustrate the impact under these different payment schemes we take Spain as an example. While CASE C introduces a sudden drop into the implementational phase, CASE D just starts in 2007 and all payments for the period 2000 to 2006 are set to zero. Table 4.1 (a) to (c). summarises the CP injections.

In 2009 for CASE C we observe a zero injection that introduces a sudden drop in the impact on GDP and all the other target variables. The years after 2009 have higher injections than all the other scenarios so that the Keynesian impact during the period 2010 to 2015 is more or less proportionally higher.

CASE D reports the separate impact of the CP for the period 2007 – 2013. In this case all the CP funds for the period 2000 to 2006 are set to zero and there are no impacts. Since the yearly injection reduces for the 2007 to 2013 and the overlapping of the two periods is not considered the Keynesian short-run impact is significantly lower. But the long-run impact considered as the cumulative multiplier is roughly the same for all the scenarios CASE A-D.

Table 4.1(a): Structural Fund injections (EC element) expressed as a per cent of GDP for Spain CASE A-D (GECSFRAE)

Year	CASE A	CASE B	CASE C	CASE D
1999	0,00	0,00	0,00	0,00
2000	0,02	0,02	0,02	**0,00**
2001	0,66	0,66	0,66	**0,00**
2002	0,96	0,96	0,96	**0,00**
2003	0,89	0,89	0,89	**0,00**
2004	0,82	0,82	0,82	**0,00**
2005	0,69	0,69	0,69	**0,00**
2006	0,45	0,45	0,45	**0,00**
2007	1,35	0,84	0,74	**0,11**
2008	1,24	0,97	0,71	**0,27**
2009	0,47	0,35	**0,00**	**0,35**
2010	0,41	0,36	**0,58**	**0,36**
2011	0,37	0,37	**0,51**	**0,38**
2012	0,35	0,34	**0,44**	**0,35**
2013	0,34	0,33	**0,73**	**0,33**
2014	0,00	0,43	**0,34**	**0,43**
2015	0,00	0,42	**0,32**	**0,42**
2016	0,00	0,00	0,00	0,00
2017	0,00	0,00	0,00	0,00
2018	0,00	0,00	0,00	0,00
2019	0,00	0,00	0,00	0,00
2020	0,00	0,00	0,00	0,00

Table 4.1(b): Percentage increase in the level of GDP. due to the Structural Funds (EC element)for Spain CASE A-D

Year	CASE A	CASE B	CASE C	CASE D
1999	0,00	0,00	0,00	0,00
2000	0,03	0,03	0,03	0,00
2001	0,78	0,78	0,78	0,00
2002	1,22	1,22	1,22	0,00
2003	1,26	1,26	1,26	0,00
2004	1,28	1,28	1,28	0,00
2005	1,22	1,22	1,22	0,00
2006	0,98	0,98	0,98	0,00
2007	2,11	1,48	1,35	**0,13**
2008	2,17	1,74	1,39	**0,35**
2009	1,34	1,07	**0,58**	**0,49**
2010	1,24	1,06	1,24	**0,55**
2011	1,18	1,09	1,22	**0,62**
2012	1,17	1,07	1,18	**0,62**
2013	1,16	1,06	1,58	**0,63**
2014	0,74	1,21	1,15	**0,80**
2015	0,69	1,24	1,13	**0,83**
2016	0,66	0,72	0,71	**0,33**
2017	0,63	0,66	0,66	**0,29**
2018	0,61	0,63	0,63	**0,27**
2019	0,59	0,61	0,61	**0,26**
2020	0,05	0,59	0,59	**0,25**

Table 4.1(c): Cumulative Structural Fund multiplier for Spain CASE A-D

Year	CASE A	CASE B	CASE C	CASE D
1999	0,00	0,00	0,00	0,00
2000	1,15	1,15	1,15	0,00
2001	1,17	1,17	1,17	0,00
2002	1,23	1,23	1,23	0,00
2003	1,30	1,30	1,30	0,00
2004	1,36	1,36	1,36	0,00
2005	1,43	1,43	1,43	0,00
2006	1,51	1,51	1,51	0,00
2007	1,52	1,55	1,55	1,21
2008	1,56	1,58	1,60	1,27
2009	1,64	1,66	1,70	1,33
2010	1,71	1,73	1,74	1,40
2011	1,78	1,79	1,79	1,46
2012	1,84	1,85	1,84	1,52
2013	1,90	1,91	1,87	1,58
2014	1,98	1,95	1,93	1,63
2015	2,06	2,00	1,99	1,68
2016	2,13	2,08	2,07	1,79
2017	2,20	2,15	2,14	1,88
2018	2,27	2,22	2,21	1,97
2019	2,33	2,29	2,28	2,06
2020	2,34	2,36	2,35	2,14

[5] A note on trade impacts of Cohesion Policy

5.1 Cohesion Policy programs and their trade impact

The purpose of this section is to form a picture about changes in the expected trade developments due to the application of Cohesion Policy programs in the recipient countries. This is all the more important because the existing literature on modelling the economic impact of Cohesion Policy support has been relatively silent on this theme.

As a start we can assume that the bulk of the Cohesion Policy funds will be used to develop physical and human infrastructure, and to carry out research and development. This kind of basic public investment programme is likely to have smaller manufactured import contents than one might expect in the course of the wider export-led growth strategies that most of the new member states have so far pursued or intend to pursue. This means that the use of Cohesion Policy is unlikely to generate any very strong demand for the injection of imports in the form of raw materials and semi-manufactured products (as reflected in the HERMIN variable FDOT, an sectoral output-weighted measure of domestic demand).

The development of physical infrastructure due to Cohesion Policy implies, however, some increase in imports of manufactured goods to be used in the production of plant and machinery as well as in building and construction. In addition, due to the Keynesian multiplier effects that come through the induced growth of private consumption, one should expect an upturn in the import of consumer goods as well. The development of human capital and the execution of R&D may also have some import content, particularly in the form of scientific and business services, intellectual property rights, etc.

While additional imports can be expected from the start of the Cohesion Policy period, additional exports associated with the CP interventions, are only expected to emerge gradually from the middle of the CP implementation period and to continue after the termination of the programme. If the underlying strategic investment programmes are well designed, it is expected that the infrastructural improvements will do away with bottlenecks to expanding certain economic activities that produce also for export. By the end of the CP period we may expect a certain production diversion development: capacities that served development activities within the country, will have to look for other (international) markets due the phasing out of internal demand that was fuelled by CP-related investments.

5.2. HERMIN and the treatment of international trade

The HERMIN macro-model framework handles all three aspects of GDP in the national accounts: output, expenditure and income. All three measures of GDP need to be identical, subject to a statistical discrepancy. This implies that while most subcomponents are determined behaviourally, two need to be determined residually through appropriate "closure rules", in order to force equality between the three GDP measures. In the HERMIN framework, profits (YC) are determined from the output-income identity. The net trade balance (i.e., exports less imports, NTS) is determined from the output-expenditure identity. In other words, HERMIN endogenises the behaviour of the net trade balance, but not the separate behaviour of exports and imports.[19]

[19] The residual determination of the net trade balance is theoretically consistent with the traded/non-traded disaggregation that is at the heart of HERMIN.

Although it does not model exports and imports directly, HERMIN does deal with interactions between the country being modelled and the rest of the world, particularly in the form of external demand (through demand in the country's export markets), through the constraining influence of external prices on internal competitiveness, and through the impacts of absorbing Cohesion Policy funding transfers from abroad. These international effects work directly through the sectoral output equations.

Since the separate behaviour of exports and imports is not modelled directly, one would need to establish a satellite trade module for the HERMIN model if the separate impacts on exports and imports needed to be examined. The net trade balance is endogenous, and the (identity) relationship between the net trade balance (NTS), exports (X) and imports (M) can be written as:[20]

(4.1) $$NTS = X - M$$

If one projects imports (M), then one can derive exports (X) from this identity, since NTS is determined within the HERMIN model simulation. Having separated exports and imports, one could then examine the impact of Cohesion Policy on these variables, in addition to the impacts on the net trade balance that are determined internally in the HERMIN simulations.

5.3. A framework for trade impact analysis using HERMIN

We should make clear at the start that trade impacts can be modelled only for such Cohesion Policy funding recipients that are sovereign states and not regions of such states (such as the Italian *Mezzogiorno* and East Germany). For regions there are usually no statistics for international trade. If, however, there were such data, they would be incomplete either because they contained all external exchanges, including those with the "mother" country which have nothing to do with international trade, or because they would be confined to exports and imports proper leaving and entering the region, but without the supporting supplier and user connections in the "mother" country.

Accordingly, we deal with sixteen countries: four "old" EU member states (Greece, Ireland, Portugal and Spain), as well as the twelve "new" EU member states. The former COMECON new member states of Central and Eastern Europe have an impressive fifteen years of post-liberalisation development behind them in terms of building up trade relations in general, and of orienting their trade towards the EU, in particular. Tables 5.1(a) shows that most of the new EU members are small economies that have used their transition to the market to make their economies substantially more open than they had been before. In the same period, they have become more integrated with the European Union as well. In fact, they are more integrated than some of the old member states. Table 5.1(b) is the equivalent table for the four "old" EU member states, for the longer period 1985-2005.

[20] The variables NTS, X and M are in constant base-year 2000 prices. Obviously there are equivalent variables in current prices (NTSV, XV and MV), which are not relevant to the present calculation of "real" trade impacts.

Table 5.1(a): Measuring the evolving degree of openness: exports (X) and imports (M) as percentage of GDP

“New” EU member states

	Estonia		**Latvia**		**Lithuania**		**Poland**		**Czech Republic**		**Slovakia**	
	X/GDP (%)	*M/GDP (%)*	*X/GDP (%)*	*M/GDP (%)*	*X/GDP (%)*	*M/GDP (%)*	*X/GDP (%)*	*M/GDP (%)*	*X/GDP (%)*	*M/GDP (%)*	*X/GDP (%)*	*M/GDP (%)*
1995	57.3	60.5	36.0	39.0	41.5	42.8	19.7	19.6	43.6	44.7	53.0	52.8
1996	56.3	62.3	42.0	48.6	47.3	50.4	20.8	23.6	44.3	48.3	49.9	57.9
1997	65.1	72.0	43.5	47.5	50.7	56.9	22.0	27.0	49.2	52.9	52.8	61.5
1998	71.2	79.2	43.1	53.4	49.4	56.2	24.2	30.8	55.1	58.1	59.2	69.0
1999	72.0	75.2	39.6	49.7	42.0	50.1	22.5	29.6	56.9	59.7	66.1	68.9
2000	84.9	88.5	41.3	48.3	44.6	50.8	26.9	33.2	63.9	67.0	70.9	73.4
2001	80.7	85.4	41.1	51.0	50.9	56.3	27.4	31.1	69.6	73.9	73.0	80.3
2002	75.8	83.6	40.8	50.4	56.7	61.8	28.2	31.4	69.1	75.5	72.9	80.2
2003	76.3	86.4	39.9	52.9	55.2	62.2	31.0	33.0	72.0	79.3	81.5	83.1
2004	83.1	92.7	40.2	56.8	54.3	67.3	33.5	36.0	82.8	89.0	84.1	86.6
2005	89.7	95.5	43.7	58.1	58.0	72.8	34.2	35.5	85.7	87.4	90.5	95.5

	Hungary		**Slovenia**		**Malta**		**Cyprus**		**Romania**		**Bulgaria**	
	X/GDP (%)	*M/GDP (%)*	*X/GDP (%)*	*M/GDP (%)*	*X/GDP (%)*	*M/GDP (%)*	*X/GDP (%)*	*M/GDP (%)*	*X/GDP (%)*	*M/GDP (%)*	*X/GDP (%)*	*M/GDP (%)*
1995	39.5	40.3	47.0	48.9	109.8	128.6	47.7	48.2	20.9	22.9	N/A	N/A
1996	43.6	43.5	46.7	48.4	97.4	114.0	48.5	51.1	20.7	24.2	N/A	N/A
1997	51.5	51.6	50.1	52.0	87.0	96.4	48.9	50.4	24.8	27.9	N/A	N/A
1998	57.8	61.0	51.7	54.6	90.7	95.2	47.1	49.1	24.2	30.9	61.0	55.6
1999	62.2	66.3	49.8	55.8	94.5	100.9	48.8	48.2	26.5	30.2	52.8	55.4
2000	72.1	75.7	54.8	58.2	91.6	102.4	50.8	51.2	31.6	37.0	56.9	60.7
2001	75.6	77.4	56.6	58.3	89.5	93.7	51.7	51.3	34.4	42.6	55.8	62.1
2002	76.0	79.9	57.8	58.5	93.7	90.9	47.7	49.7	38.6	45.6	55.5	60.6
2003	77.0	83.4	58.2	60.9	93.6	98.9	45.5	46.4	39.6	50.0	54.9	64.0
2004	86.3	92.2	63.1	66.6	96.7	102.4	45.4	49.2	41.6	56.3	58.6	69.0
2005	92.4	94.5	67.3	68.7	88.8	98.4	44.9	48.9	43.3	63.9	N/A	N/A

Table 5.1(b): Measuring the evolving degree of openness: exports (X) and imports (M) as percentage of GDP

"Old" EU member states

	Greece		**Ireland**		**Portugal**		**Spain**	
	X/GDP (%)	*M/GDP (%)*	*X/GDP (%)*	*M/GDP (%)*	*X/GDP (%)*	*M/GDP (%)*	*X/GDP (%)*	*M/GDP (%)*
1985	13.5	16.0	37.4	39.3	21.2	17.8	15.6	9.7
1986	15.7	18.2	38.5	41.7	21.3	19.5	14.9	10.8
1987	17.0	18.9	42.2	42.7	22.3	22.7	14.8	12.7
1988	15.7	19.2	44.5	43.4	22.4	24.8	14.6	14.1
1989	15.7	20.7	45.6	45.6	23.6	24.6	14.2	15.8
1990	15.0	22.2	46.9	45.4	24.4	26.7	14.3	16.8
1991	15.0	22.6	48.6	45.5	23.7	27.5	15.2	18.1
1992	16.2	22.4	53.4	47.6	23.9	29.6	16.2	19.2
1993	16.2	23.2	57.6	50.3	23.5	29.1	17.9	18.7
1994	16.9	22.9	61.9	54.2	25.4	31.6	20.5	20.4
1995	16.9	24.3	68.7	58.4	26.6	32.8	21.9	22.1
1996	17.1	25.3	72.1	61.3	27.2	33.3	23.6	23.5
1997	19.8	27.8	77.1	65.1	27.7	35.1	26.1	25.5
1998	20.0	29.2	86.0	75.2	28.8	38.4	26.9	28.1
1999	22.8	32.5	89.6	76.2	28.7	40.3	27.6	30.4
2000	24.9	35.8	98.0	84.4	29.9	40.8	28.9	32.0
2001	23.5	32.3	100.6	85.6	29.8	40.3	29.1	32.4
2002	21.0	30.8	98.6	82.0	29.9	39.5	28.9	32.7
2003	20.4	31.0	95.2	77.8	31.0	39.5	29.1	33.7
2004	22.1	32.9	97.2	80.5	32.0	41.6	29.3	35.7
2005	22.1	31.6	95.6	81.1	32.1	42.1	28.7	36.9

According to the export/GDP ratio, Table 5.1(a) shows that among the "new" EU member states in the year 2005 (the latest year for which full national accounting information is available), Hungary is the most open (with an export/GDP percentage of 92.4 per cent in 2005), followed closely by Slovakia (90.5%), Estonia (89.7%), Malta (88.8%) and the Czech Republic (85.7%). These five countries also have the highest import/GDP ratios.

Poland has the lowest export/GDP ratio (34.2%), with Romania (43.3%) and Bulgaria (56.6%) somewhat higher. However, Poland is by far the largest of the "new" member state economies, and large economies tend to be less open, in the sense that their manufacturing sectors tend to be much more diversified than in smaller economies, thus producing more of their requirements internally (other things being equal).

Two other patterns are notable. First, with the exception of Malta and Cyprus, the new member state economies have progressively become more open between 1995 and 2005. Second, it should also be noted that some of these economies run very large balance of trade deficits, with Romania and Bulgaria the most extreme cases.

Eight former COMECON countries joined the EU in 2004, and Bulgaria and Romania followed in 2007. But the extent of their pre-accession trade integration suggests that, contrary to what international economics suggests, they may not further increase substantially their integration with the EU through the processes of trade creation and diversion. The data from 1995-2005 (i.e., the sample used to calibrate the HERMIN models) suggest that they have already accomplished a high degree of trade integration during the past decade.[21] From the point of view of openness, the prospects are similar: trade openness has no limits, while the share of EU in a country's trade is limited by 100%. However, most of the economies of the new members are already fairly open, and neither accession, nor convergence and increasing cohesion is likely dramatically to make them more open to trade. Of course, the nature of their future trade within the EU will evolve as the new member states develop and converge through modernising their manufacturing, market services and agricultural sectors.

Turning to Table 5.1(b), we show the degree of openness of the four "old" member states that were classified as (mainly or entirely) Objective 1. Here Ireland is the extreme outlier, with the highest measure of openness on the basis of export/GDP ratio of all sixteen countries being analysed (95.6%). The least open is Greece (22.1%), with Portugal (32.1) and Spain (28.7) in the intermediate range. These three countries have significant trade deficits, while Ireland runs a large trade surplus.[22]

5.4 Results of the calculations

We now simulate the CASE B variant of Cohesion Policy described in the Annex Tables 8-14 above. This is the case where the "n+2" rule is invoked, and where the annual expenditure is spread fairly evenly over the nine-year period. In Tables 5.2(a) and (b) below we present the simulation results for the Cohesion Policy impacts on the net trade balance, expressed as a percentage of GDP (NTSVR, in HERMIN notation). We also include the impacts on the

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21 See Gács J. (Ed.) (1999) *Macroeconomic Developments in the Candidate Countries with Respect to the Accession Process,* PREPARITY Project 02 Vienna: WIFO-IIASA, December 1999, 147 pages, for further details.

22 It should be noted that Ireland's surplus on the balance of payments on current account is smaller that its trade surplus, since there are large-scale net factor income outflows from profit repatriation by multinationals.

public sector borrowing requirement, expressed as a percentage of GDP (GBORR in HERMIN notation). Note that a positive sign on NTSVR implies that Cohesion Policy increases the trade surplus expressed as a percentage of GDP (or equivalently, reduces any trade deficit). A positive sign on the PSBR variable (GBORR) implies that Cohesion Policy increases the borrowing requirement (or, equivalently, reduces any surplus).

In the case of Table 5.2(a), the Cohesion Policy shock operates over the implementation period 2004-2015, except for Romania and Bulgaria, where it does not commence until 2007. After 2015, the Cohesion Policy funding reverts to zero, and it is the accumulated improvements in the stock of infrastructure, of human capital and of R&D that continues to provide a boost to the economy (relative to the "no-CP" baseline case.

In all twelve cases, the impact on the net trade balance (NTS) is negative. In Table 5.2(a) this is expressed as a percentage of GDP, and the different impacts can be compared across countries. The impact on the public sector borrowing requirement (GBORR, as a percentage of GDP) is uniformly negative. This is not surprising, since the Cohesion Policy funding injection of EU aid is not co-financed by any domestic public contribution that would place pressure on the borrowing requirement. The fact that the borrowing requirement falls is due to revenue buoyancy created by the impacts of Cohesion Policy investments on tax bases (e.g., private consumption, numbers employed, etc.).

Since most of the "new" member states were running large trade deficits in the year 2005, and were projected to continue running deficits out for many years, this is a disturbing finding. It is of the nature of Cohesion Policy investments that their supply-side benefits take some time to manifest themselves, and Table 4.2(a) shows that only in the three Baltic States does the impact on the trade balance turn positive (relative to the baseline) before the termination year 2015 (invoking the "n+2" rule). Also, it is only in the case of the three Baltic States that the eventual turnaround in the trade balance effect is bigger than the deterioration that was experienced during implementation.

Since a high proportion of trade by the "new" member states is with the rest of the EU, and mainly with the "old" EU-15, this means that one of the side effects of Cohesion Policy during the implementation years is to suck in imports of capital and other goods and services, thereby mitigating some of the funding costs of the main donor countries. However, since the HERMIN models are simulated as stand-alone national models, and not as a simultaneous system that includes the rest of the EU, it is difficult to give precise quantification of these mainly East-West trade impacts in aggregate.

In Table 5.2(b) we present the Cohesion Policy trade impacts for the four "old" Objective 1 countries. Here the CP shock is more modest, particularly in the period 2007-2015. Consequently, the impacts of the trade balance are correspondingly small, although the pattern of negative impacts on the trade balance during implementation, followed by positive impacts after termination, are also found. In the case of Greece, it should be noted that the significant negative impacts on the trade balance in the period 2001-2015 are not offset by significant positive impacts after 2015. This is just another element of the generally low predicted impacts on the Greek economy that were noted in the previous section.

Table 5.2(a) : Net trade balance impacts of Cohesion Policy: "New" EU member states

	Estonia		Latvia		Lithuania		Poland		Czech Republic		Slovakia	
	NTSVR	*GBORR*	*NTSVR*	*GBORR*	*NTSVR*	*GBORR*	*NTSVR*	*GBORR*	*NTSVR*	*GBORR*	*NTSVR*	*GBORR*
2003	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2004	-0.4	-0.2	-0.4	-0.3	-0.4	-0.2	-0.3	-0.1	-0.1	-0.2	-0.4	-0.2
2005	-0.4	-0.3	-0.6	-0.4	-0.6	-0.3	-0.2	-0.1	-0.1	-0.2	-0.4	-0.2
2006	-0.7	-0.6	-0.3	-0.5	-0.6	-0.3	-0.4	-0.2	-0.3	-0.4	-0.6	-0.3
2007	-1.2	-1.1	-1.0	-1.5	-1.8	-1.0	-1.2	-0.6	-0.8	-1.1	-1.8	-0.9
2008	-1.5	-1.6	-1.1	-2.1	-2.2	-1.5	-1.6	-0.9	-1.3	-2.0	-2.8	-1.5
2009	-0.9	-1.5	-0.2	-1.8	-1.1	-1.3	-1.0	-0.9	-1.2	-2.2	-2.3	-1.4
2010	-0.6	-1.6	-0.1	-1.8	-0.7	-1.4	-0.9	-0.9	-1.1	-2.4	-2.3	-1.5
2011	-0.4	-1.7	0.0	-1.9	-0.2	-1.5	-0.9	-1.0	-1.1	-2.5	-2.4	-1.6
2012	0.0	-1.6	0.3	-1.9	0.6	-1.4	-0.7	-1.0	-0.8	-2.5	-2.1	-1.5
2013	0.4	-1.6	0.5	-1.8	1.5	-1.4	-0.5	-1.0	-0.7	-2.5	-2.0	-1.5
2014	0.6	-1.8	0.4	-2.2	2.6	-1.6	-0.9	-1.2	-0.9	-3.0	-2.5	-1.8
2015	1.1	-1.9	0.7	-2.2	4.6	-1.6	-0.7	-1.2	-0.7	-3.1	-2.4	-1.8
2016	2.3	-0.9	1.5	-0.9	6.0	-0.8	1.0	-0.7	0.7	-1.5	0.1	-0.7
2017	2.4	-0.8	1.1	-0.8	7.8	-0.7	1.0	-0.6	0.7	-1.2	0.2	-0.6
2018	2.5	-0.7	0.9	-0.7	10.0	-0.7	0.9	-0.6	0.7	-1.2	0.2	-0.6
2019	2.7	-0.7	0.8	-0.6	13.0	-0.6	0.8	-0.6	0.7	-1.1	0.2	-0.5
2020	2.9	-0.6	0.7	-0.6	17.1	-0.6	0.8	-0.6	0.7	-1.0	0.1	-0.5

	Hungary		Slovenia		Malta		Cyprus		Romania		Bulgaria	
	NTSVR	*GBORR*	*NTSVR*	*GBORR*	*NTSVR*	*GBORR*	*NTSVR*	*GBORR*	*NTSVR*	*GBORR*	*NTSVR*	*GBORR*
2003	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2004	-0.2	-0.1	-0.1	0.0	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0
2005	-0.3	-0.2	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0
2006	-0.4	-0.3	-0.2	-0.1	-0.2	-0.2	0.0	-0.1	0.0	0.0	0.0	0.0
2007	-1.1	-0.7	-0.5	-0.4	-0.7	-0.6	-0.2	-0.2	-0.5	-0.3	-0.8	-0.2
2008	-1.8	-1.2	-0.8	-0.6	-1.1	-1.0	-0.3	-0.3	-1.1	-0.8	-2.0	-0.6
2009	-1.6	-1.2	-0.7	-0.6	-0.8	-1.1	-0.2	-0.3	-1.2	-1.2	-2.5	-0.9
2010	-1.6	-1.3	-0.7	-0.7	-0.8	-1.2	-0.1	-0.3	-1.0	-1.4	-2.6	-1.0
2011	-1.6	-1.4	-0.6	-0.7	-0.7	-1.4	-0.2	-0.3	-0.9	-1.6	-2.6	-1.1
2012	-1.4	-1.3	-0.5	-0.7	-0.5	-1.4	-0.1	-0.3	-0.6	-1.6	-2.3	-1.2
2013	-1.3	-1.3	-0.5	-0.7	-0.4	-1.5	-0.1	-0.3	-0.4	-1.7	-2.1	-1.2
2014	-1.7	-1.5	-0.6	-0.8	-0.7	-1.8	-0.2	-0.4	-0.6	-2.0	-2.9	-1.5
2015	-1.6	-1.5	-0.6	-0.8	-0.6	-1.9	-0.2	-0.4	-0.3	-2.1	-2.8	-1.6
2016	0.5	-0.8	0.3	-0.3	1.1	-0.9	0.2	-0.1	1.2	-1.4	0.8	-0.8
2017	0.5	-0.7	0.3	-0.2	0.9	-0.8	0.2	-0.1	1.1	-1.2	0.8	-0.7
2018	0.6	-0.7	0.3	-0.2	0.9	-0.8	0.1	-0.1	1.1	-1.1	0.8	-0.7
2019	0.6	-0.6	0.3	-0.2	0.8	-0.7	0.1	-0.1	1.0	-1.1	0.8	-0.7
2020	0.6	-0.6	0.3	-0.2	0.8	-0.7	0.1	-0.1	1.0	-1.0	0.8	-0.6

Table 5.2(b) : Net trade balance impacts of Cohesion Policy: "Old" EU member states

	Greece		**Ireland**		**Portugal**		**Spain**	
	NTSVR	*GBORR*	*NTSVR*	*GBORR*	*NTSVR*	*GBORR*	*NTSVR*	*GBORR*
1999	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2000	0.0	0.0	-0.1	-0.1	-0.6	-0.3	0.0	0.0
2001	-0.9	-0.9	-0.3	-0.2	-0.7	-0.4	-0.5	-0.3
2002	-0.7	-0.7	-0.3	-0.3	-1.0	-0.6	-0.7	-0.5
2003	-0.5	-0.6	-0.2	-0.3	-1.0	-0.7	-0.6	-0.5
2004	-0.8	-1.0	-0.1	-0.3	-0.9	-0.8	-0.5	-0.5
2005	-0.8	-0.8	0.0	-0.3	-0.6	-0.8	-0.3	-0.5
2006	-1.0	-1.0	0.0	-0.3	-0.4	-0.7	-0.2	-0.4
2007	-1.9	-1.9	0.0	-0.2	-0.8	-1.1	-0.4	-0.5
2008	-2.1	-2.3	0.0	-0.2	-1.1	-1.3	-0.5	-0.6
2009	-0.7	-1.1	0.1	-0.2	-0.2	-0.8	-0.1	-0.4
2010	-0.5	-1.0	0.1	-0.2	-0.2	-0.9	-0.1	-0.3
2011	-0.6	-1.0	0.1	-0.2	-0.3	-0.9	-0.1	-0.3
2012	-0.6	-1.0	0.1	-0.1	-0.2	-0.9	-0.1	-0.3
2013	-0.6	-0.9	0.1	-0.1	-0.2	-0.9	-0.1	-0.3
2014	-0.8	-1.1	0.0	-0.1	-0.4	-1.0	-0.1	-0.4
2015	-0.8	-1.2	0.0	-0.1	-0.3	-1.0	-0.1	-0.4
2016	0.1	-0.4	0.1	-0.1	0.5	-0.5	0.2	-0.2
2017	0.1	-0.3	0.1	-0.1	0.5	-0.5	0.1	-0.2
2018	0.1	-0.2	0.1	-0.1	0.4	-0.4	0.1	-0.1
2019	0.1	-0.2	0.1	-0.1	0.4	-0.4	0.1	-0.1
2020	0.1	-0.2	0.0	-0.1	0.3	-0.4	0.1	-0.1

5.5 Annex to Section 5

A more detailed modelling of trade implications of alternative development paths using HERMIN would consist of three steps:

i. Projecting exports and imports in the CP recipient countries over the period 2000-2020, where the exact period will depend on the Cohesion Policy programming period for each country;

ii. Calculating alternative paths of exports and imports in the recipient countries according to the base-run and the CP-run of the HERMIN exercise;

iii. Calculating country-specific trade impacts for the main trade partners of the recipient countries, particularly for the rest of the EU.

(i) Projecting general trends of trade development

To start the modelling of trade developments, one would focus on a side relationship (i.e., external to the HERMIN model framework) between real growth of GDP (GDPM) and real growth of total imports (M). Experience shows that the elasticity of imports to GDP in the period 1995-2005 was in the range 2.0 to 2.5, and this was confirmed by carrying out individual regressions using the HERMIN database. Experience also suggests that the import elasticities in the period of the impact of CP funds will decline relative to those experienced in the 1990s, and are more likely to be in the range 1.25 – 1.5.

We could use these elasticities in side calculations make the link between the growth rate of GDP for the base-run and for the CP-run on the one hand, and the growth of imports, on the other. The HERMIN model projection simulations provide the future path of GDP. The side relationship could then be used to infer a plausible projection for total imports (M). When GDP (GDPM) and imports (M) are known, exports (X) could be derived from the net trade balance identity (NTS).

(ii) Calculating alternative paths of aggregate exports and imports

a) The HERMIN Cohesion Policy simulations provide us with the likely impact of CP on GDP (GDPM) and on the net trade balance (NTS), both expressed in constant base year 2000 prices.

b) From step (i) above, we could use the baseline simulation results for GDP (GDPM) and for the net trade balance (NTS) to derive projected "without-CP" paths for imports (M) and exports (X).

c) In order to derive the projected paths for imports and exports in the "with-CP" case, we need to make assumptions based on the expected pattern of exports and imports in the period when structural and cohesion programs are carried out. More precisely, we could assume that the difference in the trade balances as between the "with-CP" case (NTS_{CP}) and the "baseline/without-CP" case (NTS_B) is "absorbed" by larger imports during the implementational years of the CP run (M_{CP}) compared to the base run (M_B) over the implementation period.

d) We then assume that the difference thereafter is absorbed by the larger exports in the "with-CP" run (X_{CP}) compared to the "without-CP/base" run (X_B).[23]

(iii) Calculating country-specific trade impacts on partners

In order to determine the distribution of the aggregate additional exports and imports across partner countries, we utilize the available trade shares. Ideally, we could use a more formalised gravity model of trade.[24]

Starting from the last year for which there are data (i.e., 2005), we could project baseline imports (M_B) using the following relationships:

(4.2) $$\Delta M_B / M_B = 1.25 * \Delta GDPM_B / GDPM_B$$

which implies

(4.3) $$M_{Bt} = (1.0 + 1.25 * \Delta GDPM_{Bt} / GDPM_{Bt}) M_{B(t-1)}$$

Selecting an elasticity of 1.25 (i.e., a 1 per cent increase in GDP generates a 1.25 per cent increase in imports) is a fairly conservative figure. For the years for which Cohesion Policy operates (see footnote), we could use the following equation to generate the changed imports situation (with fixed values of 1.25 for the elasticity of imports with respect to GDP),:

(4.4) $$\Delta M_{CP-B} = 1.25 * (M/GDPM)|_B * \Delta GDPM_{CP-B}$$

Hence, for the implementational periods, imports will rise relative to the no-CP baseline since the CP impacts on GDP during implementation are always positive, even if they differ in size as between countries. Once we know the impacts of CP on the net trade balance (NTS) – derived from the HERMIN simulation - and on imports (M) – derived using equation (4.4) - we can derive the CP impacts on exports residually from the identity (4.1) above.

23 The CP funds operate over different periods. For the "old" member states, they start in 2000. For the ten new member states (excluding Bulgaria and Romania), they start in 2004. For Bulgaria and Romania, they start in 2007.

24 Gravity model calculations show the difference between potential and actual trade between pairs of countries, indicating the pressure for higher or lower than average growth of exports to certain trade directions in order to catch up with the potential level of trade.

[6] Concluding remarks

Previous attempts to quantify the likely impacts of Cohesion Policy have come in for severe criticism.[25] Some of these criticisms are justified, particularly insofar as they refer to the relatively poor quality of Cohesion Policy investment data. For example, in the present study, as in previous ones, we are obliged to use CP financial allocation data as equivalent to actual investment data. Clearly these two kinds of data are closely related to each other, but the absence of actual data of actual investments, with the correct timing, forces us to use the financial planning data. In an ex-ante study, there is probably no way out of the dilemma. But for ex-post studies, the errors in timing could be serious, at least during the implementation phase.

When it comes to questions concerning the reliability of the HERMIN (or any other) economic model, other issues arise. For example, how appropriate is the structure of the model as a tool for investigating the medium- to long-term impacts of Cohesion Policy on growth and development, as distinct from the short-term (Keynesian) impacts that arise during implementation?

Even within an acceptable model structure, how reliable is the calibration of the behavioural equations? Here we are captives of the quality of the available data, and there are serious deficiencies with respect to availability and reliability. As explained in Annex III, it is not possible to carry out formal econometric testing with a sample of only 10 annual observations. The problem is compounded when the ten-year period is one of rapid structural change.

But even if one accepts the HERMIN-type neo-Keynesian macro-econometric model structure, and the data are reliable, what about the manner in which the Cohesion Policy mechanisms are incorporated into the models, and the manner in which the "spillover" mechanisms are handled? Only in the cases of Spain, and to a lesser extent Ireland, is there any body of micro-economic and cost-benefit analysis research upon which the macro-spillover mechanisms can be calibrated. In the absence of such research, one is forced to draw on international research from large developed economies, and regions of such economies, and to use these findings as substitutes for the missing results for the new member states.

In the case of Poland, research to address this gap in micro-evaluation is being initiated. Previous work on East Germany is also useful. But until such work is fully integrated into the standard approaches to monitoring and evaluating Cohesion Policy implementation, we will continue to be forced to use international research findings in the areas of infrastructural, human capital and R&D spillover mechanisms.

[25] A recent report by the Court of Auditors was particularly critical of the use of previous HERMIN models in the ex-post evaluation of CSF 1994-99.

Annex I: The detailed presentation of the impact results

The attached XLS files show the results of an impact analysis of the EU cohesion policy for the period 2000-2006 and the period 2007-2013 for the supported countries and macro-regions using individual HERMIN models. The countries / regions involved in this analysis are the twelve new Member states (including Bulgaria and Romania), Spain, Greece, Portugal Ireland and the two Objective 1 "macro-regions" of Germany and Italy.

The task of this short note is to explain the content of the attached XLS files for each of the Countries / Regions that has been examined. Two scenarios have been set-up together with DG Regional Policy:

Scenario A: For the period 2000-6 the payment profile is based on actual spending for the period 2000 to 2006 and a distribution of the unspent rest equally over the years 2007 and 2008. For the period 2007-13 the planned figures are used as they were delivered by DG Regional Policy. For the latter period it is assumed that all money is distributed during the period and that the (n+2)-rule is not applied.

Scenario B: In this second scenario we apply the same payment profile for the period 2000-2006 as in Scenario A. For the SF period from 2007 to 2013 the payment profile of former period is used, i.e., the average spending per year from a six country average. The time profile was delivered by DG Regional Policy and is given as:

Year	Percentage
2007	3,3
2008	8,2
2009	11,0
2010	11,6
2011	12,3
2012	11,6
2013	11,4
2014	15,3
2015	15,3

There are two XLS-files for each country or region. They are distinguished by the character "A" and "B". For example, the results for Estonia and Scenario "A" are shown in file

`ESTONIA_NSRF_A_Impacts.xls`

And those for Scenario "B" in

`ESTONIA_NSRF_B_Impacts.xls`

In general, the results are stored as:

`COUNTRY_NSRF_X_Impacts.xls`

With "`COUNTRY`" indicating the recipient and "`X`" indicating the scenarios "`A`" or "`B`".

Inside each XLS-file four different measures are used to measure the impact of the Structural Fund interventions. They refer to two different simulations one with and the other without Structural Fund interventions. These are:

`_pdif:`	The percentage difference for a given variable between the simulation with SF and the baseline scenario. `(Y_NSRP - Y_base)/Y_base*100`
`_dif:`	The absolute difference for a given variable between the simulation with SF and the baseline scenario. `(Y_NSRP - Y_base)`
`_base:`	The absolute value for a given variable in the baseline scenario. `(Y_base)`
`_NSRF:`	The absolute value for a given variable in the SF scenario. `(Y_NSRP)`

In detail, the XLS-files show (from left to right, starting in column B):

KGINFR_pdif:	the percentage increase in the stock of physical infrastructure over the baseline (without SF) caused by the SF policy shock.
KTRNR_pdif:	the percentage increase in the stock of human capital over the baseline (without SF) caused by the SF policy shock.
KRTRIRDR_pdif:	the percentage increase in the stock of research and development over the baseline (without SF) caused by the SF policy shock.
GDPFC_pdif:	the percentage rise in Gross Domestic Product at Factor Cost in constant prices over the baseline (without SF) caused by the SF policy shock.
L_pdif:	the percentage rise of total employment over the baseline (without SF) caused by the SF policy shock.
L_dif:	the absolute rise of total employment (in 1000) over the baseline (without SF) caused by the SF policy shock.
UR_dif:	the decline / rise in the unemployment rate (in percentage points) over the baseline (without SF) caused by the SF policy shock.
LPROD_pdif:	the percentage rise of total productivity over the baseline (without SF) caused by the SF policy shock.
CONS_pdif:	the percentage rise in total consumption at constant prices over the baseline (without SF) caused by the SF policy shock.
G_pdif:	the percentage rise in the volume of total public consumption at constant prices over the baseline (without SF) caused by the SF policy shock.

I_pdif: the percentage rise in total investment at constant prices over the baseline (without SF) caused by the SF policy shock.

PGDPFC_pdif: the percentage change in in the level of the deflator of aggregate GDP at Factor Cost over the baseline (without SF) caused by the SF policy shock.

WT_pdif: the percentage change in the level of average earnings in manufacturing over the baseline (without SF) caused by the SF policy shock.

POT_pdif: the percentage change in the level of the deflator of manufacturing GDP over the baseline (without SF) caused by the SF policy shock.

PCONS_pdif: the percentage change in the level of the deflator of household consumption over the baseline (without SF) caused by the SF policy shock.

WTDOT_base: the growth rate of average earnings in manufacturing in percentage in the baseline scenario.

WTDOT_NSRF: the growth rate of average earnings in manufacturing in percentage in the NSRF scenario.

ULCT_pdif: the percentage change in the level of unit labour cost in manufacturing GDP over the baseline (without SF) caused by the SF policy shock.

RULCT_pdif: the percentage change in the level of real unit labour cost in manufacturing GDP over the baseline (without SF) caused by the SF policy shock.

PCOMPT_pdif: the percentage change in the international price competitiveness (PCOMPT: defined as the ratio of manufacturing prices (POT) over world prices (PWORLD)) over the baseline (without SF) caused by the SF policy shock.

NTSVR_dif: the change in percentage points in the net trade surplus (expressed as a percentage of GDP) over the baseline (without SF) caused by the SF policy shock.

GBORR_dif: the change in percentage points in the net trade surplus (expressed as a percentage of GDP) over the baseline (without SF) caused by the SF policy shock.

GECSFRAE_NSRF: the EU Structural Funds as a percentage share of GDP

GECSFRAP_NSRF: the EU Structural Funds and national co-finance as a percentage share of GDP

GDPM_pdif: the percentage difference in GPD between the NSP-simulation and the baseline

CumGDP:	the cumulated difference in GPD between the NSP-simulation and the baseline
CumCSF:	the cumulated injection of Structural Fund interventions expressed as a percentage in GPD
CumMult:	the quotient of CUMGDP over CUMCSF to measure the total impact of the CSF interventions. Since this measure is scale-free, it can be used for comparisons between countries.

Table 1: CASE A: Structural Fund injections (EC element) expressed as a per cent of GDP (GECSFRAE)

Date	Bulgaria	Cyprus	Czech Republic	Estonia	Greece	Hungary	Ireland	Latvia	Lithuania	Poland	Portugal	Romania	Slovakia	Slovenia	Spain	East Germany	Mezzo-giorno	Malta
1999																		
2000							0.19				0.95				0.02	0.17	0.74	
2001					1.42		0.38				1.20				0.66	0.63	0.14	
2002					0.92		0.46				1.83				0.96	0.66	0.69	
2003					0.77		0.38				1.96				0.89	0.60	1.33	
2004		0.04	0.24	0.57	1.29	0.25	0.33	0.66	0.52	0.45	1.88		0.39	0.11	0.82	0.70	1.19	0.14
2005		0.06	0.19	0.70	1.11	0.40	0.23	0.97	0.83	0.33	1.57		0.44	0.21	0.69	0.76	1.30	0.09
2006		0.10	0.43	1.17	1.46	0.63	0.20	1.05	0.83	0.69	1.31		0.58	0.31	0.45	0.69	1.41	0.30
2007	2.43	1.41	3.38	4.08	3.79	3.80	0.27	5.63	4.77	4.27	3.49	1.46	3.92	2.13	1.35	1.30	3.31	2.69
2008	3.35	1.17	3.29	3.97	3.58	3.75	0.24	5.61	4.61	4.20	3.35	1.93	3.87	2.06	1.24	1.27	3.23	2.65
2009	4.33	0.71	2.70	2.86	1.26	3.03	0.08	3.69	3.06	2.97	1.65	2.38	2.95	1.66	0.47	0.67	1.34	2.15
2010	4.40	0.49	2.65	2.89	1.22	3.03	0.06	3.85	3.08	2.89	1.61	2.62	3.01	1.62	0.41	0.65	1.32	2.14
2011	4.53	0.28	2.61	2.92	1.16	2.99	0.04	4.00	3.09	2.90	1.56	2.60	3.03	1.58	0.37	0.64	1.27	2.11
2012	4.66	0.28	2.56	2.94	1.12	2.99	0.04	4.14	3.10	2.91	1.51	2.57	3.03	1.54	0.35	0.62	1.26	2.08
2013	4.77	0.28	2.51	2.96	1.08	2.98	0.04	4.26	3.09	2.91	1.46	2.53	2.98	1.50	0.34	0.61	1.23	2.05

Table 2: CASE A: Cumulated injections of Structural Funds (EC element). expressed as a percentage of GDP

Date	Bulgaria	Cyprus	Czech Republic	Estonia	Greece	Hungary	Ireland	Latvia	Lithuania	Poland	Portugal	Romania	Slovakia	Slovenia	Spain	East Germany	Mezzo-giorno	Malta
1999					0.00		0.00				0.00							
2000					0.00		0.19				0.95				0.02	0.17	0.74	
2001					1.42		0.57				2.16				0.69	0.80	0.87	
2002					2.35		1.02				3.98				1.64	1.46	1.56	
2003		0.00	0.00	0.00	3.12	0.00	1.40	0.00	0.00	0.00	5.94		0.00	0.00	2.53	2.06	2.90	0.00
2004		0.04	0.24	0.57	4.41	0.25	1.73	0.66	0.52	0.45	7.82		0.39	0.11	3.36	2.76	4.09	0.14
2005		0.10	0.42	1.27	5.51	0.65	1.97	1.63	1.34	0.78	9.39		0.83	0.32	4.05	3.52	5.39	0.23
2006	0.00	0.20	0.85	2.43	6.97	1.28	2.17	2.68	2.17	1.47	10.70	0.00	1.42	0.63	4.50	4.21	6.80	0.52
2007	2.43	1.61	4.24	6.52	10.77	5.08	2.44	8.31	6.94	5.74	14.19	1.46	5.34	2.76	5.85	5.51	10.11	3.21
2008	5.78	2.78	7.53	10.49	14.35	8.83	2.68	13.92	11.56	9.95	17.54	3.39	9.20	4.83	7.09	6.79	13.34	5.86
2009	10.10	3.49	10.22	13.35	15.61	11.85	2.75	17.60	14.62	12.92	19.19	5.77	12.16	6.49	7.56	7.45	14.68	8.01
2010	14.50	3.98	12.88	16.23	16.83	14.88	2.81	21.45	17.70	15.81	20.80	8.39	15.17	8.11	7.97	8.10	16.00	10.16
2011	19.04	4.26	15.48	19.15	18.00	17.88	2.85	25.45	20.80	18.71	22.36	10.99	18.20	9.69	8.34	8.74	17.27	12.27
2012	23.69	4.55	18.04	22.09	19.12	20.86	2.89	29.59	23.90	21.62	23.87	13.56	21.24	11.23	8.70	9.36	18.53	14.35
2013	28.46	4.82	20.55	25.06	20.20	23.84	2.93	33.84	26.99	24.53	25.33	16.09	24.22	12.74	9.03	9.97	19.77	16.41
2014	28.46	4.82	20.55	25.06	20.20	23.84	2.93	33.84	26.99	24.53	25.33	16.09	24.22	12.74	9.03	9.97	19.77	16.41
2015	28.46	4.82	20.55	25.06	20.20	23.84	2.93	33.84	26.99	24.53	25.33	16.09	24.22	12.74	9.03	9.97	19.77	16.41
2016	28.46	4.82	20.55	25.06	20.20	23.84	2.93	33.84	26.99	24.53	25.33	16.09	24.22	12.74	9.03	9.97	19.77	16.41
2017	28.46	4.82	20.55	25.06	20.20	23.84	2.93	33.84	26.99	24.53	25.33	16.09	24.22	12.74	9.03	9.97	19.77	16.41
2018	28.46	4.82	20.55	25.06	20.20	23.84	2.93	33.84	26.99	24.53	25.33	16.09	24.22	12.74	9.03	9.97	19.77	16.41
2019	28.46	4.82	20.55	25.06	20.20	23.84	2.93	33.84	26.99	24.53	25.33	16.09	24.22	12.74	9.03	9.97	19.77	16.41
2020	28.46	4.82	20.55	25.06	20.20	23.84	2.93	33.84	26.99	24.53	25.33	16.09	24.22	12.74	9.03	9.97	19.77	16.41

Table 3: CASE A: Percentage increase in the level of GDP. due to the Structural Funds (EC element)

Date	Bulgaria	Cyprus	Czech Republic	Estonia	Greece	Hungary	Ireland	Latvia	Lithuania	Poland	Portugal	Romania	Slovakia	Slovenia	Spain	East Germany	Mezzo-giorno	Malta
1999					0.00		0.00				0.00				0.00	0.00	0.00	
2000					0.00		0.25				0.77				0.03	0.16	0.53	
2001					1.74		0.57				1.01				0.78	0.61	0.03	
2002					1.15		0.80				1.69				1.22	0.68	0.50	
2003		0.00	0.00	0.00	1.08	0.00	0.83	0.00	0.00	0.00	1.99		0.00	0.00	1.26	0.66	0.98	0.00
2004		0.04	0.42	0.69	1.91	0.21	0.89	0.76	0.56	0.26	2.14		0.39	0.10	1.28	0.81	0.85	0.16
2005		0.07	0.36	0.95	2.14	0.36	0.89	1.25	1.02	0.24	2.10		0.48	0.20	1.22	0.92	0.98	0.11
2006	0.00	0.12	0.86	1.77	2.77	0.62	0.87	1.56	1.21	0.54	1.97	0.00	0.70	0.31	0.98	0.88	1.09	0.38
2007	1.65	1.60	6.97	6.39	6.50	3.66	1.00	8.17	6.68	3.19	4.24	1.76	4.53	2.14	2.11	1.57	2.73	3.51
2008	2.71	1.58	7.99	7.77	6.58	4.41	1.00	9.64	8.05	4.14	4.32	3.07	5.42	2.37	2.17	1.61	2.55	3.76
2009	3.85	1.19	7.59	7.08	3.33	4.27	0.77	7.75	6.95	3.97	2.92	4.43	5.04	2.17	1.34	1.01	0.97	3.48
2010	4.47	0.99	8.16	7.71	3.30	4.67	0.73	8.35	7.53	4.38	3.02	5.68	5.54	2.27	1.24	1.00	1.17	3.77
2011	5.11	0.77	8.69	8.37	3.22	5.03	0.68	8.99	8.10	4.84	3.04	6.65	5.99	2.36	1.18	1.00	1.26	3.97
2012	5.75	0.77	9.18	9.05	3.23	5.41	0.66	9.65	8.67	5.28	3.09	7.58	6.42	2.45	1.17	1.01	1.37	4.17
2013	6.39	0.78	9.63	9.73	3.22	5.78	0.64	10.29	9.22	5.71	3.13	8.48	6.76	2.53	1.16	1.01	1.40	4.36
2014	3.65	0.47	4.81	5.38	1.57	3.48	0.57	4.62	5.35	4.03	1.72	5.82	3.71	1.11	0.74	0.35	0.38	1.67
2015	3.53	0.43	4.62	4.98	1.51	3.36	0.55	4.25	5.08	3.93	1.71	5.52	3.48	1.05	0.69	0.33	0.53	1.76
2016	3.41	0.41	4.45	4.69	1.42	3.25	0.52	3.98	4.83	3.83	1.64	5.33	3.29	1.00	0.66	0.32	0.59	1.65
2017	3.31	0.39	4.28	4.50	1.37	3.15	0.50	3.80	4.65	3.73	1.60	5.16	3.13	0.96	0.63	0.31	0.62	1.59
2018	3.21	0.37	4.13	4.32	1.32	3.05	0.48	3.63	4.48	3.63	1.56	4.99	2.99	0.92	0.61	0.30	0.62	1.53
2019	3.12	0.36	3.98	4.15	1.27	2.96	0.46	3.47	4.32	3.54	1.52	4.82	2.85	0.89	0.59	0.29	0.61	1.47
2020	3.04	0.34	3.84	4.00	1.23	2.87	0.44	3.32	4.16	3.45	1.48	4.65	2.71	0.86	0.57	0.28	0.59	1.41

Table 4: CASE A: Cumulative percentage increase in the level of GDP. due to the Structural Funds (EC element)

Date	Bulgaria	Cyprus	Czech Republic	Estonia	Greece	Hungary	Ireland	Latvia	Lithuania	Poland	Portugal	Romania	Slovakia	Slovenia	Spain	East Germany	Mezzo-giorno	Malta
1999					0.00		0.00				0.00							
2000					0.00		0.25				0.77				0.03	0.16	0.53	
2001					1.74		0.83				1.79				0.80	0.77	0.56	
2002					2.89		1.62				3.48				2.03	1.45	1.06	
2003		0.00	0.00	0.00	3.98	0.00	2.46	0.00	0.00	0.00	5.47		0.00	0.00	3.28	2.11	2.04	0.00
2004		0.04	0.42	0.69	5.89	0.21	3.34	0.76	0.56	0.26	7.61		0.39	0.10	4.57	2.92	2.89	0.16
2005		0.11	0.77	1.64	8.03	0.57	4.23	2.01	1.58	0.50	9.71		0.86	0.30	5.79	3.84	3.87	0.26
2006	0.00	0.23	1.63	3.40	10.79	1.20	5.10	3.57	2.79	1.04	11.69	0.00	1.56	0.61	6.78	4.72	4.96	0.64
2007	1.65	1.82	8.60	9.80	17.29	4.86	6.10	11.74	9.46	4.23	15.93	1.76	6.09	2.76	8.89	6.29	7.69	4.15
2008	4.36	3.41	16.59	17.56	23.87	9.27	7.10	21.38	17.52	8.37	20.25	4.84	11.51	5.12	11.06	7.89	10.23	7.91
2009	8.21	4.59	24.18	24.64	27.20	13.54	7.87	29.13	24.47	12.34	23.17	9.27	16.55	7.29	12.39	8.90	11.20	11.39
2010	12.68	5.59	32.34	32.35	30.50	18.21	8.59	37.48	32.00	16.72	26.20	14.95	22.09	9.56	13.63	9.90	12.37	15.16
2011	17.79	6.36	41.03	40.72	33.72	23.24	9.27	46.47	40.10	21.56	29.24	21.61	28.08	11.92	14.81	10.90	13.63	19.13
2012	23.54	7.13	50.21	49.77	36.96	28.65	9.93	56.12	48.77	26.84	32.33	29.19	34.49	14.37	15.99	11.91	15.00	23.30
2013	29.93	7.90	59.84	59.49	40.18	34.42	10.58	66.41	57.99	32.56	35.45	37.67	41.25	16.91	17.15	12.92	16.40	27.66
2014	33.58	8.37	64.65	64.87	41.75	37.90	11.15	71.02	63.34	36.59	37.17	43.49	44.96	18.02	17.89	13.27	16.78	29.33
2015	37.11	8.81	69.27	69.85	43.26	41.26	11.69	75.27	68.42	40.52	38.89	49.02	48.44	19.07	18.58	13.60	17.31	31.09
2016	40.52	9.22	73.72	74.54	44.68	44.51	12.21	79.25	73.25	44.35	40.53	54.35	51.73	20.07	19.24	13.92	17.90	32.75
2017	43.82	9.61	78.00	79.04	46.06	47.66	12.71	83.05	77.90	48.09	42.13	59.51	54.87	21.03	19.87	14.23	18.52	34.34
2018	47.04	9.98	82.13	83.36	47.38	50.71	13.20	86.69	82.37	51.72	43.69	64.49	57.86	21.95	20.48	14.52	19.14	35.86
2019	50.16	10.34	86.11	87.51	48.65	53.67	13.66	90.16	86.69	55.26	45.20	69.31	60.70	22.84	21.07	14.81	19.75	37.33
2020	53.19	10.68	89.95	91.51	49.66	56.54	14.10	93.47	90.86	58.71	46.68	73.97	63.42	23.69	21.64	15.08	20.34	38.74

Table 5: CASE A: Cumulative Structural Fund multiplier (see text for definition)

Date	Bulgaria	Cyprus	Czech Republic	Estonia	Greece	Hungary	Ireland	Latvia	Lithuania	Poland	Portugal	Romania	Slovakia	Slovenia	Spain	East Germany	Mezzo-giorno	Malta
1999					0.00		0.00				0.00							
2000					0.00		1.36				0.81				1.15	0.93	0.72	
2001					1.22		1.45				0.83				1.17	0.97	0.64	
2002					1.23		1.58				0.87				1.23	1.00	0.68	
2003		0.00	0.00	0.00	1.28	0.00	1.75	0.00	0.00	0.00	0.92		0.00	0.00	1.30	1.03	0.70	
2004		1.05	1.75	1.20	1.34	0.84	1.93	1.16	1.09	0.58	0.97		0.99	0.91	1.36	1.06	0.71	1.15
2005		1.08	1.82	1.29	1.46	0.88	2.15	1.24	1.17	0.64	1.03		1.04	0.94	1.43	1.09	0.72	1.16
2006	0.00	1.13	1.91	1.40	1.55	0.93	2.35	1.33	1.28	0.71	1.09	0.00	1.10	0.97	1.51	1.12	0.73	1.22
2007	0.68	1.13	2.03	1.50	1.61	0.96	2.50	1.41	1.36	0.74	1.12	1.21	1.14	1.00	1.52	1.14	0.76	1.29
2008	0.75	1.22	2.20	1.68	1.66	1.05	2.65	1.54	1.52	0.84	1.15	1.43	1.25	1.06	1.56	1.16	0.77	1.35
2009	0.81	1.32	2.37	1.85	1.74	1.14	2.86	1.65	1.67	0.96	1.21	1.61	1.36	1.12	1.64	1.19	0.76	1.42
2010	0.87	1.40	2.51	1.99	1.81	1.22	3.06	1.75	1.81	1.06	1.26	1.78	1.46	1.18	1.71	1.22	0.77	1.49
2011	0.93	1.49	2.65	2.13	1.87	1.30	3.25	1.83	1.93	1.15	1.31	1.97	1.54	1.23	1.78	1.25	0.79	1.56
2012	0.99	1.57	2.78	2.25	1.93	1.37	3.44	1.90	2.04	1.24	1.35	2.15	1.62	1.28	1.84	1.27	0.81	1.62
2013	1.05	1.64	2.91	2.37	1.99	1.44	3.61	1.96	2.15	1.33	1.40	2.34	1.70	1.33	1.90	1.30	0.83	1.69
2014	1.18	1.74	3.15	2.59	2.07	1.59	3.81	2.10	2.35	1.49	1.47	2.70	1.86	1.41	1.98	1.33	0.85	1.79
2015	1.30	1.83	3.37	2.79	2.14	1.73	4.00	2.22	2.54	1.65	1.54	3.05	2.00	1.50	2.06	1.36	0.88	1.90
2016	1.42	1.91	3.59	2.98	2.21	1.87	4.17	2.34	2.71	1.81	1.60	3.38	2.14	1.58	2.13	1.40	0.91	2.00
2017	1.54	1.99	3.80	3.15	2.28	2.00	4.35	2.45	2.89	1.96	1.66	3.70	2.27	1.65	2.20	1.43	0.94	2.09
2018	1.65	2.07	4.00	3.33	2.34	2.13	4.51	2.56	3.05	2.11	1.72	4.01	2.39	1.72	2.27	1.46	0.97	2.19
2019	1.76	2.14	4.19	3.49	2.41	2.25	4.67	2.66	3.21	2.25	1.78	4.31	2.51	1.79	2.33	1.49	1.00	2.28
2020	1.87	2.21	4.38	3.65	2.47	2.37	4.82	2.76	3.37	2.39	1.84	4.60	2.62	1.86	2.40	1.51	1.03	2.36

Table 6: CASE A: Impact of the Structural Fund on selected target variables in 2013

	GDPM_pdif	L_pdif	L_dif
Bulgaria	6.39	3.56	100.61
Cyprus	0.78	0.50	1.82
Czech Republic	9.63	7.57	353.03
Estonia	9.73	6.16	35.38
Greece	3.22	2.11	86.41
Hungary	5.78	4.02	158.10
Ireland	0.64	0.40	7.72
Latvia	10.29	6.65	62.47
Lithuania	9.22	5.42	76.51
Poland	5.71	2.96	399.04
Portugal	3.13	2.03	101.81
Romania	8.48	3.69	304.57
Slovakia	6.76	4.36	95.26
Slovenia	2.53	1.69	15.72
Spain	1.16	0.73	139.53
East Germany	1.01	0.80	54.39
Mezzogiorno	1.40	0.80	54.72
Malta	4.36	3.84	6.53
Total			**2053.61**

Table 7: CASE A: Impact of the Structural Fund on selected target variables in 2020 (long-run effects)

	GDPM_pdif	L_pdif	L_dif
Bulgaria	3.04	1.10	30.48
Cyprus	0.34	0.14	0.49
Czech Republic	3.84	2.28	101.77
Estonia	4.00	1.92	10.95
Greece	1.23	0.55	22.30
Hungary	2.87	1.21	48.87
Ireland	0.44	0.27	5.17
Latvia	3.32	1.39	12.66
Lithuania	4.16	1.76	24.85
Poland	3.45	1.15	165.57
Portugal	1.48	0.66	33.05
Romania	4.65	1.69	143.81
Slovakia	2.71	1.21	28.12
Slovenia	0.86	0.33	3.12
Spain	0.57	0.26	49.66
East Germany	0.28	0.12	8.24
Mezzogiorno	0.59	0.14	9.87
Malta	1.41	0.98	1.79
Total			**700.75**

Table 8: CASE B: Structural Fund injections (EC element) expressed as a per cent of GDP (GECSFRAE)

Date	Bulgaria	Cyprus	Czech Republic	Estonia	Greece	Hungary	Ireland	Latvia	Lithuania	Poland	Portugal	Romania	Slovakia	Slovenia	Spain	East Germany	Mezzo-giorno	Malta
1999																		
2000							0.19				0.95				0.02	0.17	0.74	
2001					1.42		0.38				1.20				0.66	0.63	0.14	
2002					0.92		0.46				1.83				0.96	0.66	0.69	
2003					0.77		0.38				1.96				0.89	0.60	1.33	
2004		0.04	0.24	0.57	1.29	0.25	0.33	0.66	0.52	0.45	1.88		0.39	0.11	0.82	0.70	1.19	0.14
2005		0.06	0.19	0.70	1.11	0.40	0.23	0.97	0.83	0.33	1.57		0.44	0.21	0.69	0.76	1.30	0.09
2006		0.10	0.43	1.17	1.46	0.63	0.20	1.05	0.83	0.69	1.31		0.58	0.31	0.45	0.69	1.41	0.30
2007	0.99	0.41	1.35	2.13	2.77	1.61	0.16	3.33	2.67	2.13	2.17	0.66	1.89	0.80	0.84	0.77	2.26	1.04
2008	2.46	0.60	2.28	3.10	3.05	2.65	0.18	4.54	3.65	3.11	2.65	1.56	2.91	1.37	0.97	0.98	2.63	1.76
2009	3.22	0.45	2.16	2.41	0.95	2.42	0.05	3.07	2.54	2.35	1.27	1.96	2.43	1.29	0.35	0.50	1.04	1.67
2010	3.35	0.48	2.19	2.42	1.01	2.47	0.05	3.19	2.56	2.40	1.31	1.95	2.46	1.33	0.36	0.53	1.08	1.75
2011	3.52	0.50	2.24	2.43	1.07	2.54	0.06	3.33	2.58	2.47	1.37	1.96	2.51	1.37	0.37	0.56	1.13	1.84
2012	3.28	0.46	2.04	2.18	1.00	2.32	0.05	3.08	2.32	2.26	1.26	1.75	2.27	1.25	0.34	0.52	1.05	1.73
2013	3.16	0.45	1.92	2.02	0.96	2.19	0.05	2.95	2.15	2.13	1.20	1.61	2.12	1.18	0.33	0.51	1.00	1.66
2014	4.17	0.59	2.45	2.55	1.28	2.84	0.06	3.85	2.73	2.77	1.58	2.02	2.71	1.54	0.43	0.68	1.32	2.20
2015	4.11	0.58	2.36	2.41	1.26	2.73	0.06	3.76	2.59	2.67	1.54	1.89	2.59	1.48	0.42	0.67	1.29	2.18

Table 9: CASE B: Cumulated injections of Structural Funds (EC element). expressed as a percentage of GDP

Date	Bulgaria	Cyprus	Czech Republic	Estonia	Greece	Hungary	Ireland	Latvia	Lithuania	Poland	Portugal	Romania	Slovakia	Slovenia	Spain	East Germany	Mezzo-giorno	Malta
1999					0.00		0.00				0.00				0.00	0.00	0.00	
2000					0.00		0.19				0.95				0.02	0.17	0.74	
2001					1.42		0.57				2.16				0.69	0.80	0.87	
2002					2.35		1.02				3.98				1.64	1.46	1.56	
2003	0.00	0.00	0.00	0.00	3.12	0.00	1.40	0.00	0.00	0.00	5.94		0.00	0.00	2.53	2.06	2.90	0.00
2004	0.00	0.04	0.24	0.57	4.41	0.25	1.73	0.66	0.52	0.45	7.82		0.39	0.11	3.36	2.76	4.09	0.14
2005	0.00	0.10	0.42	1.27	5.51	0.65	1.97	1.63	1.34	0.78	9.39		0.83	0.32	4.05	3.52	5.39	0.23
2006	0.00	0.20	0.85	2.43	6.97	1.28	2.17	2.68	2.17	1.47	10.70	0.00	1.42	0.63	4.50	4.21	6.80	0.52
2007	0.99	0.61	2.21	4.56	9.74	2.89	2.33	6.01	4.84	3.60	12.87	0.66	3.31	1.44	5.34	4.98	9.06	1.56
2008	3.45	1.21	4.49	7.66	12.79	5.54	2.52	10.55	8.49	6.70	15.52	2.22	6.22	2.81	6.31	5.95	11.69	3.32
2009	6.67	1.66	6.66	10.08	13.74	7.96	2.57	13.62	11.03	9.05	16.79	4.18	8.65	4.10	6.66	6.46	12.73	5.00
2010	10.02	2.14	8.85	12.49	14.75	10.43	2.62	16.81	13.59	11.45	18.10	6.14	11.11	5.43	7.01	6.99	13.81	6.74
2011	13.54	2.63	11.09	14.92	15.82	12.97	2.68	20.13	16.17	13.92	19.46	8.09	13.61	6.79	7.39	7.54	14.94	8.59
2012	16.82	3.10	13.13	17.10	16.82	15.30	2.73	23.22	18.49	16.18	20.73	9.84	15.88	8.04	7.73	8.07	15.99	10.31
2013	19.98	3.54	15.05	19.12	17.78	17.49	2.78	26.17	20.64	18.31	21.93	11.45	18.00	9.22	8.06	8.58	16.99	11.97
2014	24.15	4.13	17.50	21.67	19.06	20.32	2.84	30.02	23.38	21.07	23.51	13.47	20.71	10.76	8.49	9.26	18.31	14.17
2015	28.26	4.72	19.86	24.08	20.32	23.05	2.90	33.78	25.96	23.75	25.05	15.36	23.30	12.24	8.91	9.93	19.60	16.35
2016	28.26	4.72	19.86	24.08	20.32	23.05	2.90	33.78	25.96	23.75	25.05	15.36	23.30	12.24	8.91	9.93	19.60	16.35
2017	28.26	4.72	19.86	24.08	20.32	23.05	2.90	33.78	25.96	23.75	25.05	15.36	23.30	12.24	8.91	9.93	19.60	16.35
2018	28.26	4.72	19.86	24.08	20.32	23.05	2.90	33.78	25.96	23.75	25.05	15.36	23.30	12.24	8.91	9.93	19.60	16.35
2019	28.26	4.72	19.86	24.08	20.32	23.05	2.90	33.78	25.96	23.75	25.05	15.36	23.30	12.24	8.91	9.93	19.60	16.35
2020	28.26	4.72	19.86	24.08	20.32	23.05	2.90	33.78	25.96	23.75	25.05	15.36	23.30	12.24	8.91	9.93	19.60	16.35

Table 10: CASE B: Percentage increase in the level of GDP. due to the Structural Funds (EC element)

Date	Bulgaria	Cyprus	Czech Republic	Estonia	Greece	Hungary	Ireland	Latvia	Lithuania	Poland	Portugal	Romania	Slovakia	Slovenia	Spain	East Germany	Mezzo-giorno	Malta
1999					0.00		0.00				0.00				0.00	0.00	0.00	
2000					0.00		0.25				0.77				0.03	0.16	0.53	
2001					1.74		0.57				1.01				0.78	0.61	0.03	
2002					1.15		0.80				1.69				1.22	0.68	0.50	
2003	0.00	0.00	0.00	0.00	1.08	0.00	0.83	0.00	0.00	0.00	1.99		0.00	0.00	1.26	0.66	0.98	0.00
2004	0.00	0.04	0.42	0.69	1.91	0.21	0.89	0.76	0.56	0.26	2.14		0.39	0.10	1.28	0.81	0.85	0.16
2005	0.00	0.07	0.77	0.95	2.14	0.36	0.89	1.25	1.02	0.24	2.10		0.48	0.20	1.22	0.92	0.98	0.11
2006	0.00	0.12	1.63	1.77	2.77	0.62	0.87	1.56	1.21	0.54	1.97	0.00	0.70	0.31	0.98	0.88	1.09	0.38
2007	0.67	0.48	4.41	3.50	4.89	1.63	0.83	4.90	3.84	1.69	2.91	0.79	2.25	0.83	1.48	0.99	1.83	1.35
2008	1.87	0.77	9.59	5.78	5.63	2.96	0.87	7.50	6.10	2.93	3.54	2.28	3.89	1.51	1.74	1.25	2.13	2.45
2009	2.74	0.68	15.15	5.57	2.68	3.14	0.68	6.18	5.44	2.93	2.36	3.43	3.87	1.58	1.07	0.79	0.78	2.53
2010	3.27	0.75	21.32	6.12	2.80	3.53	0.66	6.70	5.96	3.36	2.53	4.18	4.29	1.74	1.06	0.82	1.00	2.86
2011	3.81	0.83	28.13	6.68	2.89	3.93	0.65	7.26	6.47	3.81	2.63	4.93	4.71	1.90	1.09	0.87	1.13	3.20
2012	4.08	0.84	35.04	6.80	2.85	4.07	0.64	7.30	6.58	4.04	2.61	5.37	4.79	1.90	1.07	0.85	1.14	3.25
2013	4.39	0.86	42.15	6.98	2.85	4.25	0.62	7.42	6.76	4.30	2.62	5.81	4.92	1.93	1.06	0.85	1.16	3.37
2014	5.47	1.07	50.83	8.28	3.40	5.11	0.64	9.01	7.95	5.08	3.08	6.98	5.87	2.39	1.21	1.06	1.48	4.32
2015	5.94	1.12	59.88	8.65	3.45	5.40	0.63	9.33	8.27	5.44	3.12	7.60	6.10	2.47	1.24	1.08	1.46	4.50
2016	3.63	0.49	64.44	5.07	1.52	3.36	0.53	4.38	5.05	3.91	1.64	5.58	3.48	1.07	0.72	0.34	0.35	1.61
2017	3.52	0.44	68.82	4.71	1.45	3.26	0.51	4.05	4.81	3.82	1.64	5.32	3.28	1.01	0.66	0.31	0.51	1.72
2018	3.40	0.41	73.04	4.45	1.37	3.16	0.49	3.81	4.59	3.72	1.57	5.13	3.09	0.96	0.63	0.30	0.57	1.61
2019	3.31	0.39	77.11	4.27	1.32	3.06	0.47	3.64	4.43	3.63	1.53	4.95	2.95	0.93	0.61	0.29	0.61	1.55
2020	3.21	0.38	81.04	4.11	1.27	2.97	0.45	3.47	4.27	3.53	1.49	4.78	2.81	0.89	0.59	0.28	0.61	1.49

Table 11: CASE B: Cumulative percentage increase in the level of GDP. due to the Structural Funds (EC element)

Date	Bulgaria	Cyprus	Czech Republic	Estonia	Greece	Hungary	Ireland	Latvia	Lithuania	Poland	Portugal	Romania	Slovakia	Slovenia	Spain	East Germany	Mezzo-giorno	Malta
1999					0.00		0.00				0.00				0.00	0.00	0.00	
2000					0.00		0.25				0.77				0.03	0.16	0.53	
2001					1.74		0.83				1.79				0.80	0.77	0.56	
2002					2.89		1.62				3.48				2.03	1.45	1.06	
2003	0.00	0.00	0.00	0.00	3.98	0.00	2.46	0.00	0.00	0.00	5.47		0.00	0.00	3.28	2.11	2.04	0.00
2004	0.00	0.04	0.42	0.69	5.89	0.21	3.34	0.76	0.56	0.26	7.61		0.39	0.10	4.57	2.92	2.89	0.16
2005	0.00	0.11	0.77	1.64	8.03	0.57	4.23	2.01	1.58	0.50	9.71		0.86	0.30	5.79	3.84	3.87	0.26
2006	0.00	0.23	1.63	3.40	10.79	1.20	5.10	3.57	2.79	1.04	11.69	0.00	1.56	0.61	6.78	4.72	4.96	0.64
2007	0.67	0.70	4.41	6.90	15.68	2.82	5.92	8.47	6.63	2.73	14.60	0.79	3.81	1.45	8.26	5.71	6.79	1.99
2008	2.55	1.47	9.59	12.68	21.31	5.78	6.79	15.97	12.73	5.66	18.14	3.07	7.70	2.96	10.00	6.97	8.92	4.45
2009	5.29	2.15	15.15	18.26	23.99	8.92	7.47	22.14	18.17	8.59	20.50	6.50	11.57	4.54	11.07	7.75	9.70	6.98
2010	8.56	2.91	21.32	24.38	26.79	12.45	8.13	28.84	24.13	11.96	23.03	10.69	15.85	6.27	12.13	8.57	10.69	9.84
2011	12.37	3.73	28.13	31.06	29.68	16.38	8.79	36.10	30.60	15.77	25.66	15.62	20.56	8.17	13.22	9.45	11.83	13.04
2012	16.45	4.57	35.04	37.86	32.54	20.45	9.42	43.40	37.18	19.81	28.27	20.99	25.35	10.06	14.29	10.30	12.97	16.29
2013	20.85	5.43	42.15	44.84	35.39	24.69	10.05	50.82	43.94	24.11	30.89	26.80	30.27	11.99	15.35	11.15	14.13	19.66
2014	26.32	6.50	50.83	53.12	38.79	29.80	10.69	59.84	51.89	29.19	33.97	33.78	36.14	14.38	16.57	12.21	15.60	23.98
2015	32.26	7.62	59.88	61.77	42.24	35.20	11.32	69.17	60.16	34.62	37.09	41.38	42.25	16.85	17.80	13.29	17.06	28.48
2016	35.89	8.10	64.44	66.83	43.76	38.56	11.86	73.55	65.21	38.53	38.73	46.96	45.73	17.92	18.52	13.63	17.41	30.09
2017	39.41	8.55	68.82	71.54	45.22	41.82	12.37	77.60	70.03	42.35	40.37	52.28	49.01	18.93	19.18	13.95	17.92	31.81
2018	42.82	8.96	73.04	76.00	46.58	44.98	12.86	81.41	74.62	46.07	41.94	57.40	52.10	19.90	19.81	14.25	18.50	33.43
2019	46.12	9.36	77.11	80.27	47.91	48.04	13.33	85.05	79.05	49.70	43.47	62.36	55.05	20.82	20.42	14.54	19.11	34.98
2020	49.33	9.73	81.04	84.37	49.18	51.01	13.78	88.52	83.32	53.23	44.96	67.14	57.85	21.71	21.00	14.83	19.71	36.48

Table 12: CASE B: Cumulative Structural Fund multiplier (see text for definition)

Date	Bulgaria	Cyprus	Czech Republic	Estonia	Greece	Hungary	Ireland	Latvia	Lithuania	Poland	Portugal	Romania	Slovakia	Slovenia	Spain	East Germany	Mezzo-giorno	Malta
1999					0.00		0.00				0.00				0.00	0.00	0.00	
2000					0.00		0.00				0.00				0.00	0.93	0.72	
2001					1.22		1.45				0.83				1.17	0.97	0.64	
2002					1.23		1.58				0.87				1.23	1.00	0.68	
2003	0.00	0.00	0.00	0.00	1.28	0.00	1.75	0.00	0.00	0.00	0.92		0.00	0.00	1.30	1.03	0.70	0.00
2004	0.00	1.05	1.75	1.20	1.34	0.84	1.93	1.16	1.09	0.58	0.97		0.99	0.91	1.36	1.06	0.71	1.15
2005	0.00	1.08	1.82	1.29	1.46	0.88	2.15	1.24	1.17	0.64	1.03		1.04	0.94	1.43	1.09	0.72	1.16
2006	0.00	1.13	1.91	1.40	1.55	0.93	2.35	1.33	1.28	0.71	1.09	0.00	1.10	0.97	1.51	1.12	0.73	1.22
2007	0.68	1.15	2.00	1.51	1.61	0.98	2.54	1.41	1.37	0.76	1.13	1.20	1.15	1.01	1.55	1.15	0.75	1.28
2008	0.74	1.21	2.14	1.65	1.67	1.04	2.70	1.51	1.50	0.84	1.17	1.38	1.24	1.05	1.58	1.17	0.76	1.34
2009	0.79	1.29	2.28	1.81	1.75	1.12	2.91	1.63	1.65	0.95	1.22	1.55	1.34	1.11	1.66	1.20	0.76	1.40
2010	0.85	1.36	2.41	1.95	1.82	1.19	3.10	1.72	1.78	1.04	1.27	1.74	1.43	1.16	1.73	1.23	0.77	1.46
2011	0.91	1.42	2.54	2.08	1.88	1.26	3.28	1.79	1.89	1.13	1.32	1.93	1.51	1.20	1.79	1.25	0.79	1.52
2012	0.98	1.48	2.67	2.21	1.93	1.34	3.46	1.87	2.01	1.22	1.36	2.13	1.60	1.25	1.85	1.28	0.81	1.58
2013	1.04	1.53	2.80	2.35	1.99	1.41	3.62	1.94	2.13	1.32	1.41	2.34	1.68	1.30	1.91	1.30	0.83	1.64
2014	1.09	1.57	2.90	2.45	2.04	1.47	3.76	1.99	2.22	1.38	1.44	2.51	1.74	1.34	1.95	1.32	0.85	1.69
2015	1.14	1.61	3.02	2.56	2.08	1.53	3.90	2.05	2.32	1.46	1.48	2.69	1.81	1.38	2.00	1.34	0.87	1.74
2016	1.27	1.72	3.25	2.78	2.15	1.67	4.08	2.18	2.51	1.62	1.55	3.06	1.96	1.46	2.08	1.37	0.89	1.84
2017	1.39	1.81	3.47	2.97	2.23	1.81	4.26	2.30	2.70	1.78	1.61	3.40	2.10	1.55	2.15	1.40	0.91	1.95
2018	1.52	1.90	3.68	3.16	2.29	1.95	4.43	2.41	2.87	1.94	1.67	3.74	2.24	1.63	2.22	1.43	0.94	2.04
2019	1.63	1.98	3.88	3.33	2.36	2.08	4.59	2.52	3.04	2.09	1.74	4.06	2.36	1.70	2.29	1.46	0.97	2.14
2020	1.75	2.06	4.08	3.50	2.42	2.21	4.75	2.62	3.21	2.24	1.79	4.37	2.48	1.77	2.36	1.49	1.01	2.23

Table 13: CASE B: Impact of the Structural Fund on selected target variables in 2015

	GDPM_pdif	L_pdif	L_dif
Bulgaria	5.94	3.22	90.38
Cyprus	1.12	0.86	3.10
Czech Republic	59.88	7.14	327.83
Estonia	8.65	5.43	31.00
Greece	3.45	2.33	95.01
Hungary	5.40	3.73	147.29
Ireland	0.63	0.43	8.18
Latvia	9.33	5.98	55.43
Lithuania	8.27	4.81	67.67
Poland	5.44	2.80	384.21
Portugal	3.12	2.09	104.76
Romania	7.60	3.22	267.46
Slovakia	6.10	3.97	87.92
Slovenia	2.47	1.69	15.75
Spain	1.24	0.82	156.65
East Germany	1.08	0.88	59.98
Mezzogiorno	1.46	0.88	60.07
Malta	4.50	3.99	6.92
Total			**1969.61**

Table 14: CASE B: Impact of the Structural Fund on selected target variables in 2020 (long-run effects)

	GDPM_pdif	L_pdif	L_dif
Bulgaria	3.21	1.16	32.15
Cyprus	0.38	0.15	0.54
Czech Republic	81.04	2.33	104.12
Estonia	4.11	1.98	11.29
Greece	1.27	0.57	23.26
Hungary	2.97	1.25	50.36
Ireland	0.45	0.27	5.25
Latvia	3.47	1.45	13.24
Lithuania	4.27	1.81	25.51
Poland	3.53	1.17	168.43
Portugal	1.49	0.66	33.19
Romania	4.78	1.74	147.99
Slovakia	2.81	1.26	29.15
Slovenia	0.89	0.34	3.24
Spain	0.59	0.26	51.03
East Germany	0.28	0.13	8.41
Mezzogiorno	0.61	0.14	9.82
Malta	1.49	1.04	1.89
Total			**718.86**

Annex II: The HERMIN-5 models: A theoretical description

[II.1] The HERMIN country models: theoretical structure

II.1.1 Introduction

The reform and expansion of EU regional investment programmes into the so-called *Community Support Frameworks* (CSFs) in the late 1980s presented the EC as well as domestic policy makers and analysts with major challenges. Although the CSF investment expenditures were very large, this in itself was not a problem for policy design or analysis.[26] Indeed. evaluating the macroeconomic impact of public expenditure initiatives had been an active area of work since quantitative models were first developed in the 1930s (Tinbergen, 1939).[27] What was special about the CSF was its declared goal to implement policies whose explicit aim was to transform and modernise the underlying structure of the beneficiary economies in order to prepare them for greater exposure to international competitive forces within the Single Market and EMU. Thus, CSF policies moved far beyond a conventional demand-side stabilization role, being aimed rather at the promotion of structural change, accelerated long-term growth and real cohesion through mainly supply-side mechanisms.

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

The revival of the study of growth theory in the mid-1980s provided some guidelines to the complex issues involved in designing policies to boost a country's growth rate, either permanently or temporally, but was more suggestive of potential growth mechanisms than of actual magnitudes of growth to be expected in any specific country situation (Barro and Sala-y-Martin, 1995; Jones, 1998). Furthermore, the available empirical growth studies tended to be predominantly aggregate and cross-country rather than disaggregated and country-specific.[28] Yet another complication facing the designers and analysts of the early CSFs was that the four main beneficiary countries - Greece, Ireland, Portugal and Spain - were on the geographical periphery of the EU, thus introducing spatial issues into their development processes (e.g., distance from the developed agglomerations at the core of the EU). With advances in the treatment of imperfect competition, the field of economic geography (or the study of the location of economic activity) had also revived during the 1980s (Krugman, 1995; Fujita, Krugman and Venables, 1999). But the insights of the new research were confined to small theoretical models and seldom penetrated up to the type of large-scale empirical models that are typically required for realistic policy analysis.

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[26] Typically, CSF expenditures range from about 1 percent of GDP annually in the case of Spain to over 3 per cent in the case of Greece. The macro consequences are clearly important.

[27] Tinbergen's early contribution to the literature on the design and evaluation of supply-side policies still reads remarkably well after almost 40 years (Tinbergen, 1958).

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

II.1.2 Approaches to policy modelling

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

The original HERMIN model framework drew on some aspects of the above revision and renewal of macro economic modelling. The deep origins of the HERMIN model can be found in the complex multi-sectoral HERMES model that was developed by the European Commission from the early 1980s (d'Alcantara and Italianer, 1982). HERMIN was initially designed to be a small-scale version of the HERMES model framework in order to take account of the very limited data availability in the poorer, less-developed EU member states and regions on the Western and Southern periphery (i.e., Ireland, Northern Ireland, Portugal, Spain, the Italian *Mezzogiorno*, and Greece).[29] A consequence of the lack of detailed macro-sectoral data and of sufficiently long time-series that had no structural breaks was that the HERMIN modelling framework needed to be based on a fairly simple theoretical framework that permitted inter-country and inter-region comparisons and that facilitated the selection of key behavioural parameters in situations where sophisticated econometric analysis was difficult, if not impossible.

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

II.1.3 One-sector and two-sector small-open-economy frameworks

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

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

b) Firms are able to sell as much as they desire to produce at going world prices. It rules out Keynesian phenomena right from the start.

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

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

(1.1) $$p_t = ep_t^*$$

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

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

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

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

II.1.4 The structure of a HERMIN model

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

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

(ii) It must specify the mechanisms through which a "cohesion-type" economy is connected to the external world. The external (or world) economy is a very important direct and indirect factor influencing the economic growth and convergence of the lagging EU and CEE economies, through trade of goods and services, inflation transmission, population emigration and inward foreign direct investment.

(iii) It must recognise that a possible conflict may exist between actual situation in the country, as captured in a HERMIN model calibrated with the use of historical data, and the desired situation towards which the cohesion or transition economy is evolving in an economic environment dominated by EMU and the Single European Market. In other words, calibration purely on the basis of econometrics using past data is likely to be inappropriate (even where it is feasible).

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

a) The degree of economic openness, exposure to world trade, and response to external and internal shocks;

b) The relative sizes and features of the traded and non-traded sectors and their development, production technology and structural change;

c) The mechanisms of wage and price determination;

d) The functioning and flexibility of labour markets with the possible role of international and inter-regional labour migration;

e) The role of the public sector and the possible consequences of public debt accumulation, as well as the interactions between the public and private sector trade-offs in public policies.

To satisfy these requirements, the basic HERMIN framework originally had four sectors: manufacturing (a mainly (internationally) traded sector), market services (a mainly non-traded sector, that included building and construction), agriculture and government (or non-market) services (see Kejak and Vavra, 1998; Barry et al, 2003). In the present extension of the HERMIN framework for the COHESION system, we further disaggregated the aggregate market services sector (N) into two separate sub-sectors: building and construction (B) and the rest of market services (M).[30] Given the severe data restrictions that 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 (e.g., price support and other aspects of the CAP) imply that it requires special treatment. Similarly, the government (or non-market) sector is non-traded, but is best formulated in a way that recognises that it is mainly driven by policy instruments that are available – to some extent, at least – to policy makers.[31]

The structure of the HERMIN modelling framework can be best thought as being composed of three main blocks: a supply block, an absorption block and an income distribution block. Obviously, the model functions as integrated systems of equations, with interrelationships between all their sub-components. However, for expositional purposes we describe the HERMIN modelling framework in terms of the above three sub-components, which are schematically illustrated in Figure 1.1.

Conventional Keynesian mechanisms are at the core of the short-term behaviour of a HERMIN model. When subject to a demand shock, expenditure and income distribution sub-components generate the standard income-expenditure mechanisms. For example, the implementational phase of cohesion policy has a demand component, as public expenditure is increased, but longer-term supply side benefits have not yet appeared. But the model also has many neoclassical features. Thus, output in

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

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

manufacturing is not simply driven by demand. It is also influenced by price and cost competitiveness, where firms seek out minimum cost locations for production (Bradley and Fitz Gerald, 1988). In addition, factor demands in manufacturing and market services are derived using a CES production function constraint, where the capital/labour ratio is sensitive to relative factor prices. The incorporation of a structural Phillips curve mechanism in the wage bargaining mechanism introduces further relative price effects.

The model handles the three complementary ways of measuring GDP in the national accounts, on the basis of output, expenditure and income. On the output basis, HERMIN disaggregates five sectors: manufacturing (OT), building and construction (OB), market services (OM), agriculture (OA) and the public (or non-market) sector (OG). On the expenditure side, HERMIN disaggregates into the conventional five components: private consumption (CONS), public consumption (G), investment (I), stock changes (DS), and the net trade balance (NTS).[32] National income is determined on the output side, and disaggregated into private and public sector elements.

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

[32] 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 1.1: The HERMIN Model Schema

Supply aspects

Manufacturing Sector (mainly tradable goods)

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

Building and Construction Sector (mainly non-tradable)

Output = f_6(Total Investment in Construction)
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

Market Service Sector (mainly non-tradable)

Output = f_6(Domestic Demand, World Demand)
Employment = f_7(Output, Relative Factor Price Ratio, t)
Investment = f_8(Output, Relative Factor Price Ratio, t)
Capital Stock = Investment + (1-δ)Capital $Stock_{t-1}$
Output Price = Mark-Up On Unit Labour Costs
Wage Inflation = Manufacturing Sector Wage Inflation

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

Demographics and Labour Supply

Population Growth = f_9(Natural Growth, Migration)
Labour Force = f_{10}(Population, Labour Force Participation Rate)
Unemployment = Labour Force – Total Employment
Migration = f_{11}(Relative expected wage)

Demand (absorption) aspects

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

Income distribution aspects

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

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

II.1.5 The supply side of the HERMIN model

Output determination

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

(1.2)
$$\log(OT) = a_1 + a_2 \log(OW) + a_3 \log(ULCT / POT) + a_4 \log(FDOT) + a_5 \log(POT / PWORLD) + a_6 t$$

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

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

(1.3a)
$$\log(OB) = a_1 + a_2 \log(IBCTOT) + a_3 \log(ULCB/POB) + a_4 t$$

(1.3b)
$$\log(OM) = b_1 + b_2 \log(FDOM) + b_3 \log(OW) + b_4 \log(ULCM/POM) + b_4 t$$

where IBCTOT is total investment in building and construction by all the other four sectors, FDOM is a measure of domestic demand and OW is a measure of "world" demand. The variables ULCB and ULCM are unit labour costs in building and construction and market services, respectively, and are deflated using the sectoral GDP deflators (POB and POM, respectively). Output in agriculture is modelled very simply as an inverted labour productivity equation;[33]

(1.4)
$$\log(OA/LA) = a_0 + a_1 t$$

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

[33] We take the view that progress in reforming and modernising agriculture will depend on very specific conditions in each country. Basically, we summarise these complex processes in terms of the rate of productivity growth and the associated process of labour release from the sector.

Factor demands

Macro models usually feature production functions of the general form:

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

where Q represents output, K capital stock and L employment. However, output is not necessarily actually determined by this relationship.[34] We have seen above that manufacturing output is determined in HERMIN by a mixture of world and domestic demand, together with price and cost competitiveness terms. Having determined output in this way, the role of the production function is to constrain the determination of factor demands in the process of cost minimisation that is assumed. Hence, given Q (determined as in equations 3.2 and 3.3 in a hybrid supply-demand relationship), and given (exogenous) relative factor prices, the factor inputs, L and K, are determined via optimisation behaviour of firms by the production function constraint. Hence, the production function operates in the model as a technology constraint and is indirectly involved in the determination of output. It is partially through these interrelated factor demands that the longer run efficiency enhancing effects of policy and other shocks like the 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 experience of several SOEs, especially Ireland, suggests (Bradley *et al.*, 1995), this issue is important. When an economy opens and becomes progressively more influenced by activities of foreign-owned multinational companies, the traditional substitution of capital for labour following an increase in the relative price of labour need no longer happen to the same extent. The internationally mobile capital may choose to move to a different location than seek to replace costly domestic labour. In terms of the neoclassical theory of firm, the isoquants get more curved as the technology moves away from a Cobb-Douglas towards a Leontief type.[35]

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

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

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

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

(1.7a) $$K = g_1\left(Q, \frac{r}{w}\right)$$

(1.7b) $$L = g_2\left(Q, \frac{r}{w}\right)$$

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

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

where *w* and *r* are the cost of labour and capital, respectively.[36]

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

(a) First, output in the traded sector (OT) is driven by world demand (OW) and domestic demand (FDOT), and is influenced by international price competitiveness (PCOMPT) and real unit labour costs (RULCT). In the non-traded sectors, on the other hand, we tend to find that output (OB and OM) is driven mainly by domestic demand (IBCTOT and FDOMS, respectively), with only a very limited possible role for world demand (OW) in driving OM. This captures the essential difference between the neoclassical-like tradable sector and the sheltered Keynesian non-traded sector.[37]

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

The modelling of factor demands in the agriculture sector is treated very simply in HERMIN, but can always be extended in later versions as satellite models, where the institutional aspects of agriculture are fully included. We saw above that GDP in agriculture is modelled as an inverted productivity relationship (see above). Labour input into agriculture is modelled as a (declining) time trend, and not as part of a neo-classical optimising system, as in manufacturing and market services. The capital stock in agriculture is modelled as a trended capital/output ratio.[38]

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

Sectoral wage determination

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

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

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

38 We emphasise that the simple trended relationships that we use in agriculture can always be replaced by more sophisticated models. Agriculture is "different". At this stage we merely aim to disaggregate it from the private non-agriculture sectors (T, B and M).

In the initial version of the HERMIN models in the COHESION system we adopt a simpler approach, influenced by the so-called Scandinavian model, as it applies to most small open economies (Lindbeck, 1979). Based on this approach, the behaviour of the internationally exposed manufacturing (T) sector is assumed to be dominant in relation to wage determination in the rest of the economy. The wage inflation determined in the manufacturing sector tends to be passed through to the down-stream “sheltered sectors, i.e., building and construction, market services, agriculture and non-market services, in equations of the form:

(1.8a) WBDOT = WTDOT + stochastic error

(1.8b) WMDOT = WTDOT + stochastic error

(1.8c) WADOT = WTDOT + stochastic error

(1.8d) WGDOT = WTDOT + stochastic error

where WTDOT, WBDOT, WMDOT, WADOT and WGDOT are the wage inflation rates in manufacturing, building and construction, market services, agriculture and non-market services, respectively.[39]

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) *Consumer prices*: This is the main concern of workers, and it can often deviate from producer prices.
c) *The tax wedge*: This wedge is driven by total taxation between the wage denominated in output prices and the take home consumption wage actually enjoyed by workers. Research suggests that it has at most a transitory impact (LNJ, 1990).
d) *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.
e) *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:

(1.9) $\text{Log(WT)} = a_1 + a_2 \log(\text{POT}) + a_3 \log(\text{PCONS}) + a_4 \log(\text{WEDGE}) + a_5 \log(\text{LPRT}) + a_6 \text{ UR}$

39 Equations 3.8(a)-(d) are actually behavioural, in the sense that they state a testable hypothesis. Examination of data series for the period 1995-2005 suggests that they do capture trend behaviour (i.e., differences are fairly random, and a unit coefficient on WTDOT is plausible.

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

Demographics and labour supply

In a medium-term model like HERMIN, population growth can be endogenised through a “natural” growth rate, corrected for net additions or subtractions due to migration. Net migration flows can then be modelled using a standard Harris-Todaro approach that drives migration by the relative attractiveness of the local (or national) and international labour markets, where the latter can be proxied by an appropriate destination of migrants, e.g., the UK, Germany, Ireland, etc. in the case of the new EU member states (Harris and Todaro, 1970).[40] 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.

The evolution of population tends to be fairly stable, in the absence of large migration flows. In that case, it would be simpler to treat population as exogenous, and project it using external information. However, the presence of migration flows complicates matters since population movements and shifts in the labour force can take place.

We treat population in terms of three age cohorts: pre-working age (NJUV); working age (NWORK); and post-working age (NELD). In all three cases we specify a natural growth mechanism (where the rate of growth/decline is obtained from data). However, we link net out-migration (NM) only to the working age group, based on the fact that most migrants are of working age). The three equations are as follows:

(1.10a) $\Delta NJUV = a_1\ NJUV_{-1} + \text{error term}$

(1.10a) $\Delta NWORK = b_1\ NWORK_{-1} + b_2\ NM + \text{error term}$

(1.10a) $\Delta NELD = c_1\ NELD_{-1} + \text{error term}$

Note that if net outward migration (NM) is measured as a positive number, the sign of the coefficient b_2 will be negative.

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)), is treated as a single aggregate.[41] The aggregate labour force participation rate (LFPR) can be modelled as a function of the unemployment rate (UR) and a time trend that is designed to capture slowly changing socio-economic and demographic conditions, together with the possibility of an encouraged/discouraged worker effect, proxied by the unemployment rate (UR)..

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

---

40 The Irish-UK migration relationship is long established, and explored econometrically. In the case of the new EU member states, the poor quality of migration data makes it very difficult to implement the Harris-Todaro framework, and to calibrate the parameters.

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

II.3.6 Absorption in HERMIN

Household consumption represents by far the largest component of aggregate demand in most developed economies. The properties of the consumption function play a central role in transmitting the effects of changes in fiscal policy to aggregate demand via the Keynesian multiplier. The determination of household consumption is kept simple in the basic HERMIN model, and private consumption (CONS) is determined partially by real personal disposable income (YRPERD), with the possibility of capturing a wealth effect (WNH). In other words, we assume that consumers are only partially liquidity constrained.

(1.12) $$CONS = a_1 + a_2\ YRPERD + a_3\ WNH_{-1}$$

In other words, if the coefficient a_3 is identically zero, households are assumed to be completely liquidity constrained, in the sense of having no access to savings or credit in order to smooth their consumption. In later extensions of the HERMIN model, a more sophisticated approach was adopted.[42]

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

II.1.7 National income in HERMIN

The public sector

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

One often needs a method of altering public policy within the model in reaction to the economic consequences of any given policy shock. If all the policy instruments are exogenous, this is not possible, although instruments can be changed on the basis of off-model calculations. A solution of the problem by incorporating an “intertemporal fiscal closure rule” has been suggested in Bryant and Zhang, 1994. If it is appropriate, one can include a closure or policy feed back rule in HERMIN, whose task is to ensure that the direct tax rate is manipulated in such a way as to keep the debt/GNP

[42] 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).

ratio close to an exogenous notional target debt/GNP ratio. A policy feed back rule can be based on the IMF world model, MULTIMOD (Masson *et al*., 1989), and might take the following form:

$$(1.13)\ \Delta RGTYP = \alpha\left\{\frac{(GNDT - GNDT^{*})}{GNPV}\right\} - \beta\left\{\frac{(GNDT - GNDT^{*}) - (GNDT_{-1} - GNDT^{*}_{-1})}{GNPV}\right\}$$

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

The national income identities43

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:

(1.14) 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:

(1.15) 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:

(1.16) 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

(1.17) 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 consumption function:

$$(1.18)\quad CONS = a_1 + a_2\ YRPERD + a_3\ WNH_{-1}$$

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

II.1.8 The monetary sector

Introductory remarks

Later versions of the HERMIN country models will attempt to capture realistic interactions between monetary, fiscal and cohesion policies in the examined group of countries and regions. This is not only to permit study of impacts of cohesion policies on monetary variables, but also to capture additional channels through which public policies may affect fluctuations in private sector activity (e.g. 'crowding out' effects). [44]

Unlike the cohesion and fiscal policies that operate under very similar principles in most countries and can therefore modelled within a common framework, monetary policy regimes can differ in the country group with implications for the design of the monetary sector of the specific HERMIN country models. In particular, the group of countries and regions includes countries with a fixed exchange rate (e.g. Bulgaria. Estonia, Latvia), full-fledged Inflation Targeting (IT, e.g. Czech Republic, Poland), as well as intermediate regimes (e.g. Hungary[45]).

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

The decision to develop COHESION-system as a system of country models permits an easy handling of this diversity, while preserving a comparable generic model structure across these country models. In particular, in later versions of the model system we will re-consider the need to build regime-specific monetary sectors into the country sub-models of COHESION-system that will otherwise be based on the generic model framework.

Adding the monetary sector into the generic country sub-model framework has to satisfy the following criteria:

(i) Provide for endogenous modelling of nominal interest and exchange rates, and money aggregates, and linkages to their real counterparts;
(ii) Provide for monetary transmission mechanism of monetary policy variables (nominal interest/exchange rates) into real variables of the model in the short term, while ensuring monetary neutrality of these variables in the long term.
(iii) Provide for flexibility in handling various exchange rate regimes: fixed exchange rate and inflation targeting (including, e.g. intermediate cases of an exchange rate band).

Although monetary policy models often have a large number of equations and can be fairly complicated, designing a monetary sector embodying the essential principles of monetary

44 In the present version of the model, crowding out takes place through labour market tightening (captured in the Philips curve), and through loss of international competitiveness.
45 Hungary is an Inflation Targeting country that simultaneously announces a (relatively wide) exchange rate corridor.

policy in the small open economies of our country group can be based on interactions of a very small number of key variables, such as nominal and real interest rates, nominal and real exchange rates, output, some measure of producer marginal costs, and inflation. In fact, the models employed in several central banks of the country group are essentially models of these variables only.

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

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

Monetary transmission mechanism in country sub-models

Fixed Exchange Rate Regime:

As the original HERMIN country sub-models were developed for the situation of quasi-fixed exchange rate regimes under the ERM mechanism, they already exhibit the relevant transmission channels, and modelling of the monetary sector is relatively straightforward. It consists primarily in linking movements in nominal and real interest rates to those of the world economy.[46]

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

In a future update of the COHESION-system we could to endogenise the real interest rates by introducing market nominal interest rates that will move according to:

i) the laws of international arbitrage in response to movements in the world interest rates (provided by QUEST or NiGEM) and exogenous country risk premium, and

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

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

In addition, the block of monetary aggregates could be linked to the existing equations and variables (notably, consumption, output and interest rates), building on well established concepts.

Flexible exchange rate and inflation targeting:

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

Moreover, exogenous trajectories for real exchange and interest rates trends will be introduced into the model to provide for experiments honouring monetary neutrality (see below). The monetary sector specification will guarantee that these trends are achieved in the longer term.

As above, here too the block of monetary aggregates would be linked to the existing equations and variables.

Hybrid regimes:

For regimes that will exhibit both inflation targeting through changing market interest rates and a large degree of exchange rate management, the monetary sector will be a combination of the previous two extremes. As a convenient shortcut, we could limit the interest rate sensitivity of exchange rates, assuming the (explicit or implicit) exchange rate band is maintained through intra-marginal interventions.[47] By changing the sensitivity parameter we would be able to allow for wider or narrower exchange rate bands and our final aim would be to parameterize (country specifics permitting) the choice of the exchange rate regime in the sense that the previous cases of pure inflation targeting or fixed exchange rate will result as special cases.

Monetary experiments and monetary neutrality

Operating the monetary sector and monetary policy in particular will differ according to the nature of policy experiments being carried out. In impact evaluations of cohesion policies, the effects of the policy measures need be studied over an extended period of time that well exceeds the conventional horizon of monetary fluctuations and the control horizon of monetary stabilization policies. In such applications, the basic question of interest with respect to the monetary sector will be to what extent the planned measures will constrain medium term trajectories of nominal and monetary policy variables, and the other way round. In other application, though, shorter-term fluctuations of nominal variables as well as monetary policy effects will be important, especially for instance as regards studying ‘crowding out’ options during initial cohesion policy implementation.

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

The HERMIN framework was constructed with medium-term applications in mind, which is also reflected in its operating on an annual database. Given in addition the rudimentary nature of the original framework monetary block, it can be argued that the model simulation can be thought of as providing medium trajectories of real variables (e.g. real exchange rate) independent of monetary fluctuations. Models of monetary policy fluctuations run typically on data with higher frequency and although the fluctuations usually span over several years, most actions in small open economies typically take place within at most six quarters.

Investigating medium term trajectories of monetary sector variables will therefore be relatively straightforward. In fixed exchange rate regimes, they will result from simple model simulations; in inflation targeting, on the other hand, the trajectory of nominal exchange rate will be inferred by imposing the inflation target on the actual inflation profile[48], while other variables (e.g. real exchange and interest rates) will be determined through the simulation. A similar strategy has already been used in the context of HERMIN models when studying the development options of the Czech economy in Barry et al (2003).

When interactions with shorter term monetary policy are of interest, care will be taken to ensure neutrality of monetary policy actions in the longer term.[49] For that purpose, the policy experiment will be realized through a sequence of simulations:

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

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

48 The rate of change in the nominal exchange rate in the medium-term corresponds to the rate of inflation in small open economies.

49 Such applications most likely arise in the context of active monetary policy making, i.e. Inflation Targeting regimes.

[II.2] Transmission mechanisms of cohesion policies

II.2.1 Introduction

The structure of the national HERMIN models was designed to facilitate the macro evaluation of the impacts of cohesion policies, incorporating Structural and Cohesion Funds (see Bradley, Kangur and Lubenets, 2004, for a complete set of references). In this chapter we describe the manner in which practical model-related aspects of the NDP evaluation methodology and transmission mechanisms are handled, in order to explain to a potential user of the model how it is implemented.

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

We then summarise the model-related mechanisms through which the cohesion policy impacts are modelled, and describe the type of information that is needed if the impact evaluation is to be carried out as accurately as possible.

II.2.2 Inserting the NSRF into the new model

In its most simple form, the cohesion policy data, as negotiated by the recipient country with the EC, consists of time series for the total Community (EC) funding allocation to each recipient state, usually expressed in millions of current euro.[50] In each country/region, the HERMIN notation for these basic data is GECSFEC_E, and they are given for the years 2007-2013 inclusive.[51]

As part of the negotiations with the European Commission, a domestic co-finance ratio is agreed. This percentage is designated as RDCOFIN in the formulae below.

The total EC and domestic public (EC+DP) expenditure is then split between three main economic categories using the national shares implicit in the detailed sectoral and regional Operational Programmes contained in the national cohesion policy document. These economic categories are physical infrastructure, human resources, and direct aid to the productive sectors.

The further allocation of the direct aid to productive sectors (as between manufacturing and market services, since no funds will be devoted to agriculture, post-2006) is carried out using assumed shares.

The EC total expenditure contribution for each of the years 2007 to 2013 in current euro is input as a datum (GECSFEC_E). Using the seven-year total, and the published distribution of expenditure by year, the data are derived for the seven years of NSRF 2007-2013. This is converted to national currency (GECSFEC) using exchange rate (ZZEUR)[52]

$$GECSFEC = GECSFEC\_E * ZZEUR$$

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

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

51 If the expenditures are planned to continue after the year 2013 (under the so-called "n+2" rule), then additional data are needed.

52 In the rest of this section, the letters ZZ are used to signify the two-letter country designations that are used in the COHESION system of HERMIN models. Thus, ZZ=EE for Estonia, and EEEUR is the exchange rate (i.e., the number of Estonian TOL per euro.

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

The implied domestic private (PR) co-finance contribution (GECSFPR), is derived using an assumed domestic co-finance ratio (RDCOFIN percent):[53]

$$GECSFPR = (RPRCOFIN/(100-RPRCOFIN)) * GECSFEC$$

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

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

$$GECSF = GECSFEC + GECSFDP + GECSFPR$$

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

(a) Physical infrastructure (IGVCSFXX)

(b) Human Resources (GTRSFXX), and

(c) Direct Aid to the Productive Sector (TRIXX),

where XX=EC (Community), DP (Domestic Public) and PR (Domestic Private) contribution.

The percentage share going to physical infrastructure is RIGVCSF; the share going to human resources is RGTRSF. The residual goes to direct aid to the productive sector.[54]

Physical infrastructure (PI):

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

Human resources (HR):

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

[53] Note that total EC plus DP finance is taken as the base for calculating the domestic private co-finance ratio.

[54] In the HERMIN model we further permit RIGVCSF and GTRSFEC to vary according to whether it is associated with an EC (E), domestic public (D) or domestic private (P) finance.

Direct aid to the productive sectors (APS, residual):

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

Direct aid to the productive sectors (TRIXX) is disaggregated into its three main sectoral allocations (manufacturing (T), Market Services (M) and (residually, Agriculture (A)).

Manufacturing (Percentage share = RTRIT):

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

Market Services (Percentage share = RTRIM):

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

Agriculture (residual):

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

We further disaggregate total aid to the productive sectors (APS) into two main economic categories; R&D and other direct aid. The percentage share of total APS funding (TRI) (=TRIEC+TRIDP+TRIPR) going to R&D is assumed to be RRDTCSF.

TRIRD = (RRDTCSF/100) * TRI;

The accumulation of the constant price version of these funds directed at R&D activities (TRIRD) can be used to derive a measure of a "stock" of R&D (KRTRIRD)

II.2.3 Handling cohesion policy physical infrastructure impact analysis

The HERMIN model assumes that any cohesion policy expenditure on physical infrastructure that is directly financed by EC aid subvention (IGVCSFEC) is matched by a domestically financed public expenditure (IGVCSFDP) and a domestic privately financed component (IGVCSFPR).[55] Hence, the total public and private NSRF infrastructure expenditure (IGVCSF) is defined in the model as follows (in current prices):

IGVCSF = IGVCSFEC + IGVCSFDP + IGVCSFPR

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

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

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

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

$$KGINFR = KGINF / KGINF_0$$

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

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

In the complete absence of any externality (or spillover) mechanisms, the HERMIN model calculates the demand (or Keynesian) effects of the cohesion policy infrastructure programmes, the supply effects being only included to the extent that they are captured by any induced shifts in relative prices or by any tightening of the labour market. This transitory effect will depend on the size of the policy multipliers, which are 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 cohesion policy 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-cohesion policy) projected level (KGINFR), i.e.,

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

where η is the externality elasticity. The way in which the externality elasticity can be approximately calibrated numerically, drawing on the empirical growth theory research literature, will be explained later in chapter 6. In any model-based simulations, the externality effects can be phased in over an extended period, reflecting the implementation stages of the cohesion policy programmes and the fact that benefits from improved infrastructure may only be exploited with a lag by the private sector in terms of increased activity.

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

i. The <u>direct</u> influence on manufacturing output (OT) and market services output (OM) of improved infrastructure (KGINF), i.e. any rise in the stock of infrastructure relative to the no-cohesion policy baseline (KGINFR) will be reflected in a rise in output.

ii. Total factor productivity (TFP) in manufacturing (T) as well as in market services (M) is increased

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

II.2.4 Handling cohesion policy human resources impact analysis

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

$$GTRSF = GTRSFEC + GTRSFDP + GTRSFPR$$

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

Since the complex institutional detail of the many ESF human resource training and education programmes cannot be handled in a small macroeconomic model like HERMIN, one needs to simplify drastically. Each trainee or participant in a training course is assumed to be paid an average annual income (WTRAIN), taken to be a fraction of the average industrial wage (WT). Each instructor is assumed to be paid the average annual wage appropriate to the aggregate market service sector (WM). We assume an overhead on total wage costs to take account of buildings, equipment, materials, etc (OVERHD), and a trainee-instructor ratio (TRATIO).[56] Hence, total HR expenditure (GTRSF) can be written as follows (in nominal terms):

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

where SFTRAIN is the number of trainees being supported and LINS is the number of instructors, defined as SFTRAIN/TRATIO.[57] This formula is inverted in the HERMIN model and used to estimate the approximate number of extra trainees that can be funded from cohesion policy for a given total expenditure GTRSF on human resources, i.e.,

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

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

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56 Standard parameter values of OVERHD=0.30, TMUP=0.30 and TRATIO=15 are initially assumed, but these can be modified as more detailed information becomes available.

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

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

The number of cohesion policy-funded trainees (measured in trainee-years) is accumulated into a 'stock' (KSFTRAIN) by means of a perpetual inventory-like formula, with a 'depreciation' rate of 5 per cent:[58]

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

In order to quantify the increase in the stock of human capital (measured in trainee years), we need to define the initial pre-cohesion policy stock of human capital, $KTRAIN_0$. This is a conceptually difficult challenge, and we are again forced to simplify drastically. We base our measure of human capital on the average number of years of formal education and training that the labour force has achieved prior to the implementation of cohesion policy. 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[59]

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

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

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

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

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

59 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.

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

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 cohesion policy human resource programmes. These effects are limited in magnitude. In addition, a sizeable fraction of the HR policy payments to trainees may simply replace existing unemployment transfers. The 'overhead' element of these programmes (equal to OVERHD*SFWAG) is assumed to boost non-wage public consumption directly.

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

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

here 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, will be explained later in chapter 6. In the model-based simulations, the externality effects can be phased in over an extended period, reflecting the implementation stages of the cohesion policy programmes and the fact that benefits from improved human resources may only be exploited with a lag by the private sector in terms of increased activity.

Two types of externality effects associated with human capital are introduced into the HERMIN model:[60]

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

ii. Labour embodied technical change in manufacturing (T) and in market services (M) 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.

II.2.5 Handling cohesion policy R&D impact analysis

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

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

Hence, the total public and private cohesion policy R&D expenditure (TRIRD) is defined in the model as follows (in current prices):

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

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

We accumulate the real TRIRD expenditures (RTRIRD) to obtain a real stock of R&D (KRTRIRD).[61] However, when it comes to the public sector accounts, we exclude TRIPR from public NSRF capital expenditure (GEKCSF).

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

$$RTRIRD = RRANDD+TRIRD/PCONS$$

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

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

The new (augmented) stock of R&D (KRTRIRD) is related to a baseline ex-ante stock ($KRTRIRD0_0$). Spillovers are associated with increases in this ratio (KRTRIRDR).

$$KRTRIRDR=KRTRIRD / KRTRIRD_0$$

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

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

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

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

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

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

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, is described later in Chapter 6. In any model-based simulations, the externality effects can be phased in over an extended period, reflecting the implementation stages of the ALS R&D programmes and the fact that benefits from improved R&D may only be exploited with a lag by the private sector in terms of increased activity.

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

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

ii. Total factor productivity (TFP) in manufacturing (T) as well as in market services (M) is increased

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

[II.3] Calibration of the behavioural equations

II.3.1 Introductory remarks

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

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

Having outlines all the behavioural equations in chapter 3, in this chapter we present the calibration results. In view of the extremely constrained data sets available for use (mainly for the period 1995-2005, inclusive, i.e., 11 annual observations), and the fact that the early part of the sample is still characterised by very rapid structural change, we are forced to use very simple calibration techniques.

Before proceeding with the analysis of the individual equations, a few qualifying remarks concerning our approach to calibration are appropriate. The small number of observations available prevented us from undertaking the sophisticated econometric estimation and hypothesis testing techniques commonly used to calibrate macro models. Three different approaches to model calibration (or estimation) have been used in the literature of modelling in the transition economies of the CEE region:

(i) Extending the data sample over different economic regimes

For the Polish W8-2000 model, data for the period 1960-1998 are used (Welfe, Welfe, Florczak and Sabanty, 2002). The advantage is that this provides 39 annual observations and facilitates econometric hypothesis testing and estimation. The disadvantage is that the extended data sample covers three very different economic regimes: the era of Polish Communist economic planning; the years immediately following the collapse of the Communist economic system; and the era of rapid recovery and growth that followed the post-Communist collapse, which coincides with the 1995-2005 data sample that we use in in the COHESION system for the new EU member states.

(ii) The Panel data approach

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

(iii) Simple curve-fitting to post 1995 data

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

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

There are 20 behavioural equations that have to be calibrated in each of the HERMIN country models, as follows:[62]

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

- GDP arising in marketed services (OM)
- Factor demand system in marketed services(employment (LM) and investment (IM)
- The GDP deflator for market services (POM)

[62] Malta is a special case. For that country, the three sectors T, B, M and A were amalgamated into a single "private" sector. This is noted in the next section, where results are presented.

- GDP arising in building & construction (OB)
- Factor demand system in building & construction (employment (LB) and investment (IB)
- The GDP deflator for building and construction (POB)

- GDP arising in agriculture, forestry and fishing (OA)
- Labour input in agriculture, forestry and fishing (LA)
- Fixed capital stock in agriculture, forestry and fishing (KA)

- Pre-working age population (NJUV)
- Working age population (NWORK)
- Post working age population (NELD)
- Labour force participation rate (LFPR)

- Household consumption (CONS)

- Deflator of total investment (PI)
- Deflator of private consumption (PCONS))

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

The OLS-based calibration (or curve fitting) technique is only feasible if the number of parameters in each behavioural equation is kept to an absolute minimum. Hence, all HERMIN behavioural equations are kept as simple as possible, often at the price of poor within-sample tracking. We avoid the use of any dummy variables. In particular, structures such as the CES production function are imposed to make calibration easier. There is an obvious loss in modelling sophistication and in capturing dynamics of adjustment and behaviour, but there is little or nothing that one can do about these problems. The following sections provide discussion of the calibration process for each behavioural equation and technical details on the chosen specification.

II.3.2 Calibration results for behavioural equations

The Manufacturing sector

The equation that determines manufacturing output is very difficult to calibrate, since one is trying to obtain values for up to six parameters, using only eleven observations. A series of parameter impositions needed to be made. In the first of these, we imposed values of -0.2 for the two competitiveness elasticities (a4 and a5). From the literature, we know that these elasticities tend to be low in aggregate equation specifications, and only take higher values when manufacturing output is disaggregated into NACE two and three digit level. Next, for all models, except Greece and Spain, we imposed the elasticity with respect to domestic demand as zero. For the SOEs, this is probably a very reasonable assumption, since these countries tend to import a wide range of industrial goods and other inputs that are not produced locally. It also is consistent with the low Keynesian multipliers that one typically finds in SOEs. Finally, we imposed the elasticity with respect to world demand at unity (with Greece the only exception. The problem here is that the variable OW (world imports) and time tend to be highly correlated, and the resulting multi-colinearity make the parameter estimates very imprecise.[63]

The results are presented below in Table 3.1. Since the calibration is so constrained, the only points to note are the negative time trends. We expect these to be positive in the new member states. The negative signs are probably due to the over-stating of the world output elasticity (at unity).

Table 3.1

$Log(OT) = a_1 + a_2*Log(OWM) + a_3*Log(FDOT) + a_4*Log(RULCT) + a_5*Log(PCOMPT) + a_6*T$

Country	a_1	a_2	a_3	a_4	a_5	a_6
EE	9.30929	1	0	-0.2	-0.2	0.027467
LV	6.51084	1	0	-0.2	-0.2	-0.013288
LT	8.5867	1	0	-0.2	-0.2	0.028455
PL	11.7167	1	0	-0.2	-0.2	-0.0065413
CZ	13.1847	1	0	-0.2	-0.2	-0.0068411
SK	12.3812	1	0	-0.2	-0.2	-0.015296
HU	14.563	1	0	-0.2	-0.2	0.013617
SI	8.39294	1	0	-0.2	-0.2	-0.0082674
MT*	1.90903	0.244183	0.755817	-0.3	-0.3	0
CY	6.7936	1	0	-0.2	-0.2	-0.049217
RO	9.87973	1	0	0	0	0.0015853
BG	8.27178	1	0	-0.2	-0.2	0.025271
EL	5.68448	0.2	0.370123	0	-0.563758	0
IE	9.53341	1	0	-0.2	-0.2	0.026054
PT	10.5639	1	0	-0.2	-0.2	-0.036982
ES	8.58064	1	0.311438	0	0	-0.037413

For Malta, Private sector (NACE Codes A+B+C+D+E+F+G+H+I+J+K+O+P)

In Table 3.2 we present the calibration of the joint factor demand system for manufacturing. Since we impose a CES production function, we are essentially trying to recover the underlying CES parameters, as shown in equation 3.6 in chapter 3.

Although in many cases it was possible to recover plausible values for the elasticity of substitution (SIGT), we decided to impose a common value of 0.5, i.e., mid-way between a Cobb-Douglas value of unity and a Leontief value of zero. The remaining three parameters were calibrated from the data (using a highly non-linear approach implemented with TSP batch files that will be described further in Part III). The most interesting, and economically significant, parameters is LAMT, the rate of Hicks-neutral technical progress. Values range from highs of between about 8 and 10 per cent (for Estonia, Lithuania, Poland and Ireland), to lows of 1.5 per cent for Cyprus, Greece and Spain.

63 We cannot make use of other econometric techniques to deal with multi-colinearity and unit roots, since the techniques that handle these problems require very large data samples. We have only eleven, at most.

Table 3.2

CES Production function parameter - T-sector

Country	AT	SIGT	LAMT	DELT
EE	13.23784	0.5	0.081784	0.2563
LV	1.90134	0.5	0.058922	0.91698
LT	6.99479	0.5	0.098287	0.62355
PL	10.66313	0.5	0.084248	0.59005
CZ	21.72618	0.5	0.050986	0.095489
SK	16.35741	0.5	0.059331	0.070148
HU	24.0198	0.5	0.057248	0.014875
SI	7.58541	0.5	0.054305	0.813
MT*	8.20514	0.5	0.0033104	0.8004
CY	10.70774	0.5	0.017627	0.85367
RO	4.64743	0.5	0.53277	0.77195
BG	2.68874	0.88011	0.078586	0.90775
EL	13.26701	0.5	0.014376	0.7611
IE	10.37166	0.5	0.075104	0.46855
PT	8.68192	0.5	0.025937	0.76356
ES	20.24694	0.5	0.015825	0.77565

For Malta the sector is labelled as (P) = Private sector (NACE Codes A+B+C+D+E+F+G+H+I+J+K+O+P)

The simple specification of the equation determining the deflator of manufacturing GDP (POT) seeks the balance between price taking behaviour (PWORLD) and a mark-up on unit labour costs (ULCT). Once again, free calibration gave a wide range of results. But due to extreme multi-colinearity, we considered them to be unreliable. Given the high degree of openness, we imposed a parameter of 0.8 as the elasticity of POT with respect to PWORLD. The exceptions were Romania (where a lower value was used) and Ireland (whose extreme openness dictated a higher value. The value for Malta is included in Table 3.3, but it should be recalled that this is for the aggregate of T, M, B and A sectors.

Table 3.3

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

Country	a1	a2
EE	0.095488	0.8
LV	0.077538	0.8
LT	0.100228	0.8
PL	0.075671	0.8
CZ	0.185722	0.8
SK	0.107205	0.8
HU	0.202231	0.8
SI	0.089927	0.8
MT*	0.343475	0.500088
CY	0.213055	0.8
RO	0.398853	0.427482
BG	0.8357	0.8
EL	0.108548	0.8
IE	0.084666	0.927995
PT	0.01084	0.8
ES	0.120363	0.8

For Malta, Private sector (NACE Codes A+B+C+D+E+F+G+H+I+J+K+O+P)

The fourth and last behavioural equation in the manufacturing sector determines the wage rate (or, more accurately, average annual earnings), WT. The theoretical derivation was explained in chapter 3. Early experimentation suggested that it was the consumption deflator, PCONS, rather than the GDP deflator, POT, that was the main price determinant of earnings. Since HERMIN is a medium-term model, we imposed full pass-through of prices (i.e., indexation). Experimentation also suggested that the rate of unemployment (URBAR, a two-year moving average of UR) was not very influential in wage bargaining, although negative effects were usually found. Rather than introduce spurious heterogeneity into the wage equation, we imposed a low Philips curve coefficient of -0.005, and will re-examine the issue during Phase 2 of the project. Only in Greece was a higher value used (-0.02), since the the econometrics was more sound, and suggested a higher value. The Czech model was extremely sensitive to the Philips curve coefficient, probably due to the rather low rate of unemployment. It was set at zero.

The most interesting parameter is the elasticity of wages to productivity (a_3). Only in the cases of Malta and Romania did we have to impose values. For the remainder, values ranged from a high of 0.86 (Portugal) to a low of 0.1 (Ireland), with most economies falling in the range 0.5 – 0.8. In terms of its consequences for productivity-driven inflation push, low values are better.

Table 3.4

Log(WT) = a1 + a2*Log(POT) + (1-a2)*Log(PCONS) + a3*Log(LPRT) + a4*URBAR

Country	a1	a2	a3	a4
EE	1.09447	0	0.688633	-0.005
LV	0.525878	0	0.337053	-0.005
LT	0.440842	0	0.70447	-0.005
PL	2.65541	0	0.208709	-0.005
CZ	0.935852	0	0.75581	0
SK	1.57275	0	0.639576	-0.005
HU	4.98351	0	0.31769	-0.005
SI	1.14176	0	0.47204	-0.005
MT*	-0.032102	0	0.8	-0.005
CY	1.07774	0	0.391116	-0.005
RO	-0.272805	0	0.9	-0.005
BG	1.3448	0	0.151445	-0.005
EL	0.626921	1	0.76463	-0.02
IE	2.98132	0	0.094822	-0.005
PT	0.023657	0	0.862352	-0.005
ES	1.72919	0	0.42461	-0.005

For Malta, Private sector (NACE Codes A+B+C+D+E+F+G+H+I+J+K+O+P)

The Market Services sector

Only three behavioural equations are involved in this sector, since the wage equation is determined by pass-through of inflationary trends from manufacturing. The equation specification was described in chapter 3. Although this is a predominantly non-traded sector (since only certain services can be exported), nevertheless we found some impacts of world demand (OW). This effect was highest in Latvia (transit trade), Cyprus (tourism) and Greece (tourism and international shipping).

The strongest effect was from domestic demand, and the size of the coefficient a_2 plays a major role in determining the magnitude of the Keynesian multiplier. Positive time trends were also found for some economies, and were highest in the case of Bulgaria. Since Bulgaria made a delayed transition from central planning (where the service sector was very small), this is probably a catch-up phenomenon.

Table 3.5

Log(OM) = a1 + a2*Log(FDOM) + a3*Log(OWM) + a4*Log(RULCM) + a5*T

Country	a1	a2	a3	a4	a5
EE	2.72572	0.731013	0.06265	0	0.01717
LV	2.11546	0.724462	0.415148	0	0
LT	1.75973	0.809897	0.222615	0	0
PL	7.14924	0.417142	0	0	0.023443
CZ	-0.025624	0.99073	0.08097	0	0
SK	5.26716	0.582994	0.238221	0	0
HU	5.94273	0.611436	0.036536	0	0
SI	1.38084	0.825934	0.153202	0	0
MT	n/a	n/a	n/a	n/a	n/a
CY	3.74493	0.551777	0.429601	0	0
RO	3.28775	0.669155	0	0	0
BG	3.90342	0.5	0	0	0.057059
EL	2.606	0.755359	0.283367	0	0
IE	-0.498065	1.03134	0	0	0.0049483
PT	1.09119	0.84941	0.140978	-0.485896	0
ES	4.84662	0.615091	0.139136	0	0

The CES production function was also used in the market services sector. We also imposed a uniform value of 0.5 for the elasticity of substitution, since the evidence for its size was conflicting. The most interesting finding is the uniformly lower rate of Hicks–neutral technical progress. In the case of Ireland, Portugal and Spain it was (essentially) zero. Only in the Baltic States and Bulgaria did it rise above 4 per cent.

Table 3.6

CES Production function parameter - M-sector

Country	AM	SIGM	LAMM	DELM
EE	15.0925	0.5	0.055418	0.12227
LV	3.85541	0.5	0.042139	0.83286
LT	10.53134	0.5	0.060699	0.44386
PL	22.0108	0.5	0.034486	0.40261
CZ	18.35551	0.5	0.021418	0.043026
SK	26.5656	0.5	0.016751	0.057281
HU	38.09799	0.5	0.019222	0.011928
SI	14.89656	0.5	0.010065	0.62921
MT	n/a	n/a	n/a	n/a
CY	15.01847	0.5	0.006289	0.83332
RO	13.58801	0.5	0.019509	0.76884
BG	4.66793	0.5	0.073712	0.86676
EL	19.64548	0.5	0.014643	0.67174
IE	25.27286	0.5	0.0067999	0.49483
PT	16.31567	0.5	0.0076458	0.69919
ES	25.72641	0.5	-0.0048651	0.50506

The last behavioural equation in market services determines the output deflator (POM) as a mark-up on unit labour costs, with the possibility of direct influences of world prices (PWORLD). After much data mining, we concluded that both effects play a role, and imposed long-run elasticities of 0.6 (with respect to unit labour costs) and 0.4 (with respect to world prices). Romania was the exception, where there appeared to be a much smaller world price impact.

Table 3.7

Log(POM) = a1 + a2*Log(ULCM) + (1-a2-a3)*Log(ULCM(-1)+a3*Log(PWORLD)

Country	a1	a2	a3
EE	0.533028	0.4	0.4
LV	0.556154	0.4	0.4
LT	0.632232	0.4	0.4
PL	0.626943	0.4	0.4
CZ	0.606206	0.4	0.4
SK	0.556045	0.4	0.4
HU	0.537366	0.4	0.4
SI	0.4175	0.4	0.4
MT	n/a	n/a	n/a
CY	0.61858	0.4	0.4
RO	0.912705	0.971255	0.024102
BG	0.533945	0.4	0.4
EL	0.533028	0.4	0.4
IE	0.463669	0.4	0.4
PT	0.431639	0.4	0.4
ES	0.508621	0.4	0.4

The Building and Construction sector

Although we describe the output equation determining OB as “behavioural”, it is, in effect, a quasi identity, related to an underlying input-output relationship. We link total investment in building and construction activities (IBCTOT, determined within the model as investment by type of good) to output (OB), with the possibility of a real unit labour cost effect as well (RULCB).

We noticed that in many countries the ratio of OB to IBCTOT declined steadily over time, so we allowed for this effect in the equation specification by making the elasticity of OB with respect to IBCTOT a linear function of time.

The parameters shown in Table 3.8 were fairly robust, but are difficult to interpret. During Phase 2 of the project we intend to investigate this equation further, since it plays an increasingly important role in the transmission of cohesion policy impacts.

The CES production function was also used in the building and construction sector. We also imposed a uniform value of 0.5 for the elasticity of substitution, since the evidence for its size was conflicting. The most interesting finding is that the rates of Hicks–neutral technical progress are quite scattered. In the cases of Estonia and Bulgaria, rates of 5 and 7 per cent (respectively) were found. All four “old” EU states (Greece, Ireland, Portugal and Spain) had (effectively) zero values. In the case of Cyprus and the Czech Republic, negative values were found, suggesting technical “regress” rather than technical progress.

Table 3.8

Log(OB) = a1 + (a2+a3T)*Log(IBCTOT) + a4*Log(RULCB)

Country	a1	a2	a3	a4
EE	2.24051	0.648825	0	0
LV	1.8986	0.585102	0	0
LT	2.96789	0.583387	0	0
PL	2.16747	0.780913	-0.00253916	0
CZ	-1.61103	1.10828	-0.00447937	0
SK	0	0.932025	0	0
HU	-0.240379	0.94601	0	0
SI	1.61229	0.68987	-0.00168342	0
MT	n/a	n/a	n/a	n/a
CY	1.0166	0.778761	-0.00116279	0
RO	0.423798	0.879744	0	0
BG	3.69175	0.44629	0	0
EL	-0.399187	0.961896	0	0
IE	2.18526	0.688247	0	0
PT	2.43843	0.682398	0	0
ES	1.33523	0.826001	0	0

Table 3.9

CES Production function parameter - B-sector

Country	AB	SIGB	LAMB	DELB
EE	15.99526	0.5	0.050589	0.22181
LV	3.10912	0.5	0.029744	0.90566
LT	23.33024	0.5	0.01748	0.88669
PL	11.88847	0.5	0.028419	0.23778
CZ	149.349	0.5	-0.016821	0.38833
SK	22.23986	0.5	0.033189	0.067649
HU	224.09457	0.5	0.024085	0.13312
SI	11.96495	0.5	0.011483	0.89719
MT	n/a	n/a	n/a	n/a
CY	18.08512	0.5	-0.027056	0.89878
RO	5.9599	0.5	0.043874	0.77735
BG	2.90793	0.8	0.074393	0.79003
EL	17.72533	0.5	0.0082002	0.66616
IE	37.2473	0.5	0.0049985	0.94834
PT	11.2869	0.5	0.0095403	0.84626
ES	31.41687	0.5	-0.0074306	0.9515

The last behavioural equation in the building sector determines the output deflator as a mark-up on unit labour costs (ULCB). Some lagged effects were found, and in some cases we imposed a short-run elasticity of 0.7

Table 3.10

Log(POB) = a1 + a2*Log(ULCB) + (1-a2)*Log(ULCB(-1)		
Country	**a1**	**a2**
EE	0.679656	0.477439
LV	0.84796	0.255443
LT	0.708612	0.404766
PL	0.892234	0.480349
CZ	0.726955	0.726032
SK	0.966455	0.609003
HU	0.750945	0.8
SI	0.511862	0.656598
MT	n/a	n/a
CY	0.662541	0.428933
RO	0.813014	0.874621
BG	0.845442	0.307551
EL	1.18844	0.7
IE	0.338053	0.7
PT	0.601451	0.7
ES	0.513183	0.7

The Agricultural sector

There are three simple behavioural-type equations in this sector. The first determines trend labour productivity. The second determines trend labour-release. And the third determines trend capital/labour ratio. The findings are summarise in Tables 5.11, 5.12 and 5.13.

The findings are as one might expect. Trend labour productivity is growing strongly in some of the new member states (highest at 15.3 per cent in Slovakia, and at or above 7 per cent in Estonia, Latvia, the Czech Republic, and Cyprus. Growth is lowest in Romania (only 1.7 per cent) and in Portugal (2 per cent).

5.11

Log(OA/LA) = a1 + a2*T		
Country	**a1**	**a2**
EE	3.78367	0.068666
LV	-0.514718	0.071849
LT	2.13801	0.037892
PL	2.22374	0.0394
CZ	4.92335	0.074145
SK	4.18609	0.153385
HU	7.36658	0.047918
SI	1.23669	0.027637
MT	n/a	n/a
CY	1.37785	0.074884
RO	1.06606	0.016706
BG	2.12288	0.030188
EL	1.88915	0.025465
IE	2.56461	0.03264
PT	1.64503	0.019659
ES	1.94672	0.054629

Table 3.12 shows that in all cases (even the four "old" member states), employment is declining in agriculture. The rate of decline is highest in Slovakia (9.3 per cent), followed by Estonia (7.1 per cent).

Table 3.12

Log(LA) = a1 + a2*T

Country	a1	a2
EE	4.58219	-0.071498
LV	5.53005	-0.046682
LT	5.88824	-0.030511
PL	8.06052	-0.023563
CZ	6.14559	-0.057304
SK	5.79771	-0.092685
HU	6.06459	-0.050157
SI	5.044424	-0.033385
MT	n/a	n/a
CY	3.80126	-0.061814
RO	8.26518	-0.017
BG	5.94955	-0.024198
EL	7.02737	-0.025071
IE	5.20005	-0.016811
PT	6.82937	-0.02812
ES	7.57234	-0.029695

Table 3.13 presents the calibration results for the capital/labour ratio. In some countries this is rising at a very high rate (e.g., 14.9 per cent in Latvia). However, in the case of the Czech Republic and Slovakia, the trend is almost zero, suggesting that labour release rather than investment is the driving force of productivity growth

Table 3.13

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

Country	a1	a2
EE	-0.108609	0.095225
LV	-1.84675	0.149188
LT	-0.564002	0.095834
PL	0.128223	0.065682
CZ	1.32709	-0.00791324
SK	1.41694	-0.00665061
HU	-0.020887	0.078503
SI	0.168952	0.086712
MT	n/a	n/a
CY	0.633991	0.027181
RO	0.183895	0.035148
BG	-1.33909	0.086452
EL	1.61608	0.013076
IE	1.97023	0.00675268
PT	1.94528	0.015426
ES	1.18132	-0.0031435

Demographics and labour supply

This part of the model contains four behavioural equations that determine population changes and the labour force participation rate. We had intended to have a fifth behavioural equation to determine net migration outflows, but it proved impossible to find data on these flows that was extensive and reliable enough to use. Consequently, the population equations play a rather minor role in the model, merely projecting existing natural rates of growth and decline. The results are summarised in Tables 5.14, 5.15 and 5.16. They demonstrate the well-known fact that birth rates are falling, and the pre-working age numbers are in decline in all countries in the COHESION system. The results for working age population are more varied, and numbers are still increasing in at least some of the countries (and most strongly in Slovakia, Malta and Cyprus). Finally, the post-working age population is increasing in all countries (in some cases, quite strongly), with the exception of Hungary and Bulgaria, where it is in decline.

Table 3.14

Δ(NJUV) = a1*NJUV(-1)

Country	a1
EE	-0.036411
LV	-0.038665
LT	-0.027418
PL	-0.030856
CZ	-0.022501
SK	-0.0263202
HU	-0.017158
SI	-0.23748
MT	-0.012265
CY	-0.010568
RO	-0.029174
BG	-0.034885
EL	-0.012928
IE	-0.016063
PT	-0.020129
ES	-0.020983

Table 3.15

Δ (NWORK) = a1*NWORK(-1)	
Country	**a1**
EE	-0.0031139
LV	-0.00299148
LT	-0.00302501
PL	0.00503957
CZ	0.00293892
SK	0.00765425
HU	0.000757211
SI	-0.00197021
MT	0.010572
CY	0.018269
RO	-0.00198568
BG	-0.00196216
EL	-0.00647533
IE	-0.015381
PT	-0.00492096
ES	-0.00899166

Table 3.16

Δ (NELD) = a1*NELD(-1)	
Country	**a1**
EE	0.014388
LV	0.00750301
LT	0.00942532
PL	0.011821
CZ	0.00516689
SK	0.0065078
HU	-0.00692041
SI	0.021495
MT	0.012761
CY	0.052685
RO	0.012912
BG	-0.017236
EL	0.02948
IE	0.0097718
PT	0.020359
ES	0.02238

In Table 3.17 we show the results of calibrating the labour force participation rate (LFPR). The empirical results presented something of a paradox. In many countries there were quite high effects of unemployment (the encouraged/discouraged worker effect). But these effects tended not to be observable in the historical data. In other words, large variations in unemployment rates did not seem to shift the participation rates much. In practice, LFPR was usually trended, with only very minor fluctuations. Consequently, we set the coefficient on unemployment at zero (a2), and included only the time trend.

The results are shown in Table 3.17, and we see that there are both negative and positive trends. For example, the highest positive trends are in Cyprus (0.83 percentage points per year) and Spain (0.70 percentage points per year). The highest negative trends are in Romania (minus 0.79 percentage points per year) and Bulgaria (-0.66 percentage points per year). The explanation may lie in the initial starting participation RATE. If it was low, there will be a tendency to rise. If it was initially high, there may be a tendency to fall.

Table 3.17

LFPR = a1 + a2*URBAR(-1) + a3*T

Country	a1	a2	a3
EE	75.4883	0	-0.250012
LV	70.5006	0	-0.000111042
LT	68.7123	0	0.142893
PL	68.7344	0	-0.308251
CZ	75.773	0	-0.21502
SK	68.3797	0	0.055793
HU	54.8266	0	0.332529
SI	68.1733	0	0.00555732
MT	59.926	0	-0.052738
CY	61.0919	0	0.834398
RO	70.4078	0	-0.79158
BG	79.1828	0	-0.663577
EL	57.0898	0	0.124169
IE	57.2054	0	0.52627
PT	70.4229	0	0.1888841
ES	51.8815	0	0.699987

Expenditure

The calibration results for the consumption function are shown in Table 3.18. The specification is a hybrid of the liquidity constrained "Keynesian" function (the first two terms) and a permanent income effect (the last term). Only in the cases of Poland, Hungary, Ireland and Portugal was it possible to calibrate the wealth effect plausibly. For the rest, the simple liquidity constrained version was imposed.

The most important parameter insofar as the Keynesian multiplier is concerned is the so-called "marginal propensity to consume" (or MPC). It lies in the plausible range, and is lower in the cases of the four countries which exhibited the wealth effect.

Table 3.18

CONS = a1 + a2*YRPERD + a3*WNH(-1)

Country	a1	a2	a3
EE	-4.77495	0.708794	0
LV	-169.05	0.784013	0
LT	-551.541	0.8288986	0
PL	128790	0.415929	0.03895
CZ	-86196	0.683341	0
SK	-144019	0.8492	0
HU	-916505	0.638101	0.027497
SI	1877.43	0.531284	0
MT	79.9331	0.726211	0
CY	671.321	0.61668	0
RO	-93.6569	0.828593	0
BG	2623.9	0.694735	0
EL	-2638.13	0.762472	0
IE	6144.48	0.574501	0.01411
PT	9889.03	0.551794	0.02298
ES	-11307.7	0.695694	0

Expenditure deflators

The final two behavioural equations determine the price deflators for total investment (PI) and private consumption (PCONS). In both cases these are functions of the prices of inputs to expenditure, namely the GDP deflator (PGDPFC) and the import price (PM).

In the case of the consumption deflator, we add an indirect tax term, TINC, and assume that all indirect tax changes appear as price changes, i.e., tax changes are passed on to consumption prices.

If input-output tables were available, these equations would become identities, and would be determined in terms of transformations of I-O coefficients. Our specification is an approximation, necessary in the absence of I-O tables. Due to the high degree of multi-colinearity between PGDPFC and PM, it proved difficult to obtain stable and plausible coefficients for some countries. Consequently, in order to standardise these relationships, we imposed elasticities of 0.5 on both terms, thus imposing price homogeneity.

Table 3.19

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

(apply to: PIT, PIM, PIB, PIA, PIG)

Country	a1	a2
EE	0.016263	0.5
LV	-0.0662009	0.5
LT	0.036677	0.5
PL	-0.013468	0.5
CZ	0.000740656	0.5
SK	0.00949348	0.5
HU	0.031756	0.5
SI	0.00824673	0.5
MT	0.0991153	0.5
CY	0.038074	0.5
RO	0.045	0.5
BG	-0.01609	0.5
EL	0.00075049	0.74103
IE	-0.104474	0.5
PT	-0.00230462	0.5
ES	-0.027442	0.5

Table 3.20

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

Country	a1	a2	a3
EE	-0.206536	0.5	1
LV	-0.202245	0.5	1
LT	-0.165004	0.5	1
PL	-0.207205	0.5	1
CZ	-0.165984	0.5	1
SK	-0.19443	0.5	1
HU	-0.254299	0.5	1
SI	-0.266292	0.5	1
MT	-0.103608	0.5	1
CY	-0.184955	0.5	1
RO	-0.177399	0.5	1
BG	-0.229828	0.5	1
EL	-0.208872	0.95153	1
IE	-0.247905	0.5	1
PT	-0.237951	0.5	1
ES	-0.201159	0.5	1

[II.4] Selection of spillover and other parameters

II.4.1 Introductory remarks

In this chapter we briefly review the literature on the impact of infrastructure, human capital and research and development on economic growth. We focus particularly on empirical results since these are used to guide our selection of spillover parameters in the cohesion policy transmission mechanisms in the HERMIN models.

Over the last decade there has been renewed interest in the issue of economic growth. The focus of much of this work has been to model more explicitly the factors which impact on a country's growth rate. This approach stands in contrast to the earlier growth models which explained economic growth simply through exogenous technical progress, the sources of which were not specified (see Solow, 1956). In these earlier models growth was essentially exogenously driven with policy measures changing the transition path but not the long run steady state growth rates of an economy. These models also predicted convergence among economies which due to diminishing returns to factors would arise if countries have similar rates of technical progress.

"Endogenous" growth theory has addressed these shortcomings. In particular this literature has focused on the role of spillovers or externalities which arise from particular investments, for example in human capital, infrastructure and R&D. These externalities generate additional unintended benefits to the productive capacity of an economy. More specifically, this literature has investigated how technical progress can be affected directly through investments 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 qualities[64]. In contrast to the 'exogenous' growth models, convergence is not automatic in "endogenous" growth models.

These theoretical advances have also led to an extensive empirical literature which investigates the growth effects which have been put forward. Thus, there now exists a large literature on the effect of infrastructure on growth, while that on the impacts of human capital and R&D on growth is less extensive.

II.4.2 The role of infrastructure

Much of the recent literature on the growth effects of infrastructure has focused on the estimation of the rate of return to investment in infrastructure. This rate of return is inferred from the output elasticity of infrastructure, usually estimated under the assumption that infrastructure enters the production function as a public intermediate input. An alternative approach involves the estimation of a cost function and associated factor demand functions which yields shadow values for infrastructure[65].

Overall a consensus is emerging that infrastructure has a positive impact on growth, however the size of that impact has been in dispute ever since Aschauer (1989a, 1989b) found the output elasticity with respect to infrastructure to be between 0.39 and 0.8. Taking the lower value this estimate implied that a 1% increase in the stock of infrastructure in the US ($19.38 billion) would result in an immediate increase in US output of 0.39% ($ 16.8 billion)[66]. Similar results were found by Wylie (1996) for Canada.

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64 For extensive reviews of the theoretical literature on endogenous growth see Hammond and Rodriguez-Clare, 1993 or Romer, 1994.

65 For a detailed review of both the empirical and theoretical literature see Morgenroth 2000.

66 Using this elasticity the marginal product of infrastructure would have been 0.96 in 1991!

However these results have been subjected to substantial criticism which has focused largely on the econometric estimation of the production function. Thus, Holtz-Eakin (1994) found that infrastructure had at best a negligible effect on output. Numerous studies have subsequently addressed this issue with many researchers finding a positive impact of infrastructure, but often a more modest one than found by Aschauer (1989). Overall the production function studies suggest that values for the elasticity of output with respect to infrastructure between 0.1 and 0.4 appear reasonable. Cost function studies find somewhat smaller cost elasticities of between -0.05 and -0.2 (see table 6.1 below for a comprehensive survey of the results).

Output elasticities for East Germany (the new Federal States) have so far not been published. Thus, there only exist estimates for West Germany. These estimates have been calculated using both regional and national sectoral-datasets using the cost function approach. The results from estimating a cost function can be summarised in two ways. Firstly a cost elasticity of infrastructure can be constructed and secondly the results can be expressed by shadow price of infrastructure. Estimates of the shadow values of infrastructure range from 0.0005 to 0.06 for manufacturing industries, depending on the industry or time period (Conrad and Seitz, 1994, Seitz, 1993, 94). In other words an increase in the stock of infrastructure by DM 1 would reduce unit costs by between DM 0.0005 and DM 0.06. These shadow prices when summed over industries indicates the total benefit to manufacturing, and this ranges from a total cost saving of DM 0.015 to DM 0.155 in response to a DM1 increase in infrastructure.

The cost elasticity with respect to infrastructure has been found to range between -0.07 to -0.35, implying that a one percent increase in infrastructure would reduce costs by between 0.07 and 0.35 percent (Conrad and Seitz, 1992, Seitz and Licht, 1995). An interesting result from the estimation of a cost function system using regional data for Germany is that the impact of infrastructure is larger in those regions which have a large land area such as Bavaria or North-Rhine-Westphalia (-0.34 and -0.357 respectively). This suggests that infrastructure has spatial spillovers, which are more likely to be captured in larger regions.

Since no results are available for East Germany, it is instructive to briefly focus on the results for the Cohesion Countries; Spain, Portugal, Greece and Ireland. This is particularly appropriate since the economies of these countries are not as well developed as that of West Germany and are therefore more like the East German and new EU member state economies. Consequently the estimated elasticities for these countries may be more appropriate for adoption in the HERMIN models of the COHESION system.

There have been a number of studies on the impact of infrastructure in Spain. Specifically output elasticities with respect to infrastructure of between 0.07 and 0.21 have been estimated (see Bajo-Rubi & Sosvilla-Rivero, 1993, De la Fuente & Vives, 1995, Mas et.al., 1996, Flores de Frutos et.al., 1998).

For Greece Mamatzikis (1998) finds an output elasticity with respect to infrastructure of 0.27, Rovolis and Spence (1999) find elasticitities that range from 0.25 to 0.74 for manufacturing and Baffes and Shah (1998) reports an output elasticity of 0.05. Dalmagas (1995) on the other hand obtains rather mixed results using the production function, cost function and profit function approaches. Specifically, he finds a negative output elasticity with respect to infrastructure (-1.24), implying that additional infrastructure will reduce output while the cost and profit function approaches indicate significant gains from additional infrastructure, by lowering costs by 2.35% in response to a 1% increase in infrastructure or increasing profits by 1.06% in response to this 1% increase in infrastructure. Clearly these estimates are somewhat extreme, especially in the light of the findings of the other studies.

While results for Portugal do not appear to exist, there have been a number of studies on Ireland. The only published study by Kavanagh (1997) uses the production function approach in conjunction with modern time series methods. She finds an output elasticity of 0.14 which however was not statistically significantly different from zero. Denny and Guiomard (1997) on the other hand find unrealistically high output elasticities which range from 0.93 to 6.3!

Table 4.1: Research papers examining the role of infrastructure on the economy

Study	Type of Study	National / Regional	Sectors	Functional Form	Data	Elasticity	Significance
Argimon et.al. (1995)	Empirical	National, 14 OECD Countries	GDP	Investment and Marginal capital Productivity, Production Function, Cobb Douglas	Panel, 1979 - 1988	Positive Productivity Effect Output: 0.15 to 0.21	Yes
Aschauer (1989a)	Empirical	National, USA	Private Business Economy	Production Function, Cobb Douglas	Time Series, 1949 - 1985	Output, 0.24 to 0.8	Yes
Aschauer (1989b)	Empirical	National, USA	Private Business Economy	Investment Function, Rate of return	Time Series, 1925 - 1985	Investment -0.72 to -0.99	Yes
Aschauer (1997a)	Theory, Empirical	Regional, US States	Gross State Product	Growth Regression	Cross Section 1970 - 1990	Growth 0.02 to 0.04	Yes
Aschauer (1997b)	Empirical	Regional, US States	Gross State Product	Growth Regression Employment Growth	Panel 1970 - 1990		
Baffes & Shah (1998)	Empirical	National, 21 Countries	GDP	Production Function, Translog	Pooled Time Series, 1965 - 1984	Output 0.01 to 0.16	Yes
Bairam & Ward(1993)	Empirical	National, 25 OECD Counties	Investment	Box Cox Transformations	Time Series 1950 - 1988	Crowding out	Yes
Bajo-Rubio et.al. (1999)	Empirical	Regional, 17 Spanish Regions	GDP	Growth Regression	Panel, 1967 - 1991	Growth Effect	Yes Human Capital not effective!
Bajo-Rubio & Sosvilla-Rivero (1993)	Empirical	National, Spain	GDP	Production Function, Cobb Douglas	Time Series 1964 - 1988	Output: 0.16 to 0.19 MP 0.61	Yes
Barro (1990)	Theory, Empirical	National, 47 Countries	GDP	Growth Regression	Cross Section, 1970 to 1985	Growth 0.014	No

Table 4.1 continued.

Study	Type of Study	National / Regional	Sectors	Functional Form	Data	Elasticity	Significance
Batina (1998)	Empirical	National, USA	Industrial Production	VARM	Time Series, 1948 - 1993	Output 0.02 to 0.16	
Berndt & Hansson (1991 & 1992)	Empirical	National Sweden	Business Sector	Output, Cobb Douglas, Labour Input Demand, Flexible	Time Series 1960 - 1988	Output: 0.68 to 1.6 MFP growth 0.159	Yes (but implausible) Yes
Biehl (1986)	Empirical / Data	Regional EU Regions	Regional Product		Cross Section		Yes
Biehl (1991)	Empirical	Regional EU Regions	GDP	Quasi Production Function	Cross Section	Output 0.19 to 0.5	Yes
Charlot & Schmitt (1999)	Empirical	Regional, France	Regional GDP	Production Function, Cobb Douglas, Translog	Panel 1982 - 1993	Output 0.07 to 0.32 -0.01 to 0.4	Yes
Conrad & Seitz (1992)	Empirical	National, Germany	Sectors	Cost Function, Cost Shares Translog	Time Series, Panel 1961 - 1988	Cost: 0.02 to - 0.34	Yes
Conrad & Seitz (1994)	Empirical	National, Germany	Sectors	Cost Function, Input Shares, Translog	Time Series, SUR, 1961 - 1988	Shadow value 0.01 to 0.06	Yes
Crihfield & Panggabean (1995)	Empirical	Regional, US Metropolitan Areas	Regional Income	Growth Regression	Cross Section	Mixed Results	Mixed
De Haan et.al. (1996)	Empirical	National, OECD Countries		Public Investment			
De la Fuente & Vives (1995)	Empirical	Regional, Spanish Regions		Production Function, Employment, Labour Force Participation, Human Capital Gap	Panel	Output 0.21	Yes (also has Human Capital elasticity)

Table 4.1 continued.

Study	Type of Study	National / Regional	Sectors	Functional Form	Data	Elasticity	Significance
Demetriades & Mamuneas (2000)	Empirical	National, 12 OECD Countries	Manufacturing	Output Supply and Input Demands	Panel 1972 - 1991	Supply: S-R: 1.06 L-R: 0.96	Yes
Denny & Guiomard (1997)	Empirical	National, Ireland		Production Function, Cobb Dougls	Time Series	Output:	Not reliable
Devarajan et.al. (1996)	Empirical	National, 43 Countries	GDP	Growth Regression	Pooled Time Series, 1970 to 1990	No Growth Effects	
Duggal et.al. (1995)	Theory, Empirical	National, USA	GDP	Nonlinear Production Function	Time Series, 1960 - 1989	Output: 0.18 to 0.41 Rate of Return 26% to 44%	Yes
Easterly & Rebelo (1993)	Empirical	National, 100 Countries	GDP	Growth Regressions,	Cross Section	Growth Effects	Yes
Erenburg (1993)	Empirical	National, USA		Investment Function	Time Series, 1947 - 1985	Investment Effect 0.002 to 0.22	Yes
Evans, P & Karras (1994a)	Empirical	Regional, US States	State Product	Production Function, Cobb Douglas, Translog	Panel, 1970 - 1986	Largely Negative Put Positive for Educational Services	Mixed
Feldstein & Ha (1999)	Theory, Empirical	National, Mexico	16 Sectors	Production Function, Cobb Douglas	Time Series 1970 - 1990	Output -0.24 to 0.21	
Ferreira & Issler (1995)							
Fernald (1997) and 1999)	Empirical	National, USA	29 Industries	Growth Accounting	Time Series, 1953 - 1989	Output 0.35	

Table 4.1 continued.

Study	Type of Study	National / Regional	Sectors	Functional Form	Data	Elasticity	Significance
Flores de Frutos et.al. (1998)	Empirical	National, Spain	GDP	Production Function, Cobb Douglas Dynamic Analysis	Time Series 1964 - 1992	Output: 0.21	Yes
Ford, R., and Poret, P., (1991)	Empirical	National, 11 OECD Countries	GDP	TFP , Cross Country Regression	Time Series, 1957 - 1989	MP of Infrastructure 0.45 to 1.7	Yes
Garcia-Mila & McGuire (1992)	Empirical	Regional, US States	Gross State Product	Production Function, Cobb Douglas	Panel, 1969 - 1983	Output 0.04	Yes
Garcia-Mila et.al. (1996)	Empirical	Regional, US States	Regional Product	Production Function: Cobb Douglas	Time Series, Panel	Output: -0.002 to -0.58	No
Grossman (1988)	Empirical	National, USA	GNP	Production Function, Cobb Douglas and Non Linear	Time Series, 1929 - 1982	Output 0.03 to 408	Yes
Holtz-Eakin (1994)	Empirical	Regional, US States	Gross State Product	Production Function, Cobb Douglas	Panel, 1969 - 1986	Output: -0.15 to 0.203	Mixed
Holtz-Eakin & Lovely (1995 & 1996)	Theory, Empirical	Regional, US States	Manufacturing		Panel	Indirect effect	
Holtz-Eakin & Schwartz (1995)	Empirical	Regional, US States	Gross State Product	Production Function, Cobb Douglas	Panel, 1969 - 1986	Output: 0.03 to 0.05	Yes
Hulten (1996)	Empirical	National, 42 Countries	GDP	Growth Regressions	Cross Section	Growth -0.063 to 0.248	Mixed

Table 4.1 continued.

Study	**Type of Study**	**National / Regional**	**Sectors**	**Functional Form**	**Time-Series / Cross-Section / Panel**	**Elasticity**	**Significance**
Hulten & Schwab (1991)	Empirical	Regional, US States	State Value Added	MFP	Time Series, 1951 to 1986	0	
Ingram & Liu, Z., (1997)	Empirical	National, Regional 50 Countries, 35 Urban Areas					
Kavanagh (1997)	Empirical	National, Ireland	GDP	Production Function, Cobb Douglas	Time Series, 1958 - 1990	Output	No
Keeler & Ying (1988)	Empirical	Regional, 9 US Regions	Road Freight Sector	Cost Function, Translog	Time Series, Panel	Cost -0.07	
Khan & Kumar (1997)	Empirical	National, 95 Countries	GDP	Growth Regression	Pooled Time Series, 1970 - 1990	Growth effect 0.13 to 0.29	Yes (large regional differences)
Kocherlakota & Yi (1996)	Empirical	National, USA	GNP	Time Series Analysis	Time Series, 1917 - 1988	Output 0	Yes
Looney & Frederiksen (1981)	Empirical	Regional, Mexico	Regional Income	'Production Function' Cobb Douglas	Cross Section, Grouped, 1970		Yes

Table 4.1 continued.

Study	Type of Study	National / Regional	Sectors	Functional Form	Time-Series / Cross-Section / Panel	Output Elasticity	Significance
Lynde (1992)	Empirical	National US		Profit, Cobb Douglas	Time Series	MPg: 0.09- 0.27 Profit: 1.2	Yes
Lynde & Richmond (1992)	Empirical	National, US	Aggregate productive Sector	Share equations, Translog	Time Series, 1958 - 1989	Factor Demand: K 0.71 & 0.90 L -.49 & -0.45	
Lynde & Richmond (1993a)	Empirical	National, UK	Manufacturing	Share equations, Translog	Time Series, 1966-1990	Factor Demand K L	
Lynde & Richmond (1993b)	Empirical	National, USA		Profit Function, Share Equations Translog	Time Series, 1958 - 1989	Labour Productivity Growth 0.06	Yes
Lynde & Richmond (1999)	Empirical	National, UK	Manufacturing	DEA Analysis	Time Series 1966 - 1990		
Mamatzikis (1998)	Empirical	National, Greece	Manufacturing	Cobb Douglas	Time Series, 1959 - 1993	Output 0.27	Yes
Mas et.al. (1996)	Empirical	Regional, Spain	Regional Output	Production Function, Cobb Douglas	Panel 1964 - 1991	Output 0.07 to 0.13	Yes
Merriman (1990)	Empirical	Regional, Japan, US	Regional Output, by sector	Translog	Panel, 1954 -1963	0.43 to 0.58	Yes

Table 4.1 continued.

Study	Type of Study	National / Regional	Sectors	Functional Form	Data	Elasticity	Significance
Morrison & Schwartz (1992 & 1996)	Empirical	Regional, US States	Manufacturing	Cost Function, Input demand, Generalise Leontief	Time Series, SUR, 1970 -1987	Cost: -0.16 to -0.18 (short run) Productivity growth effects Direct : 0.192 to 0.622 Indirect: -0.027 to 1.442	Yes
Morrison & Schwartz (1996)	Empirical	Regional, US States	Manufacturing	Cost Function, Input demand, Generalised Leontief	Time Series, 1971 - 1987	Cost: 0.253 (short run) 1.245 (long run)	
Munnell ed. (1990)	Review, Empirical	National, Regional, USA		Production Functions	Time Series	Output: 0.055 to 0.11	Yes
Nadiri, I & Mamuneas (1994)	Empirical	National, USA	Manufacturing Industries	Cost Function, Factor share equations, Translog	Time Series- Cross Section Pooled, 1956 - 1986	Cost -0.1182 to -0.173	Yes
Nagaraj et.al. (1998)	Empirical	Regional, Indian States		Growth Regressions	Cross Section	Growth -0.37 to 0.46	
Otto & Voss (1994)	Empirical	National, Australia	Private sector output, Sectors	Output, Cobb Douglas	Time Series, 1966 - 1990	Output 0.38 to 0.43	Yes
Otto & Voss (1996)	Empirical	National, Australia	Private Sector Output	Output, Cobb Douglas	Time Series 1959 - 1992	Output 0.1675 to 0.2961	Yes
Otto & Voss (1998)	Empirical	National, Australia	Private Sector Output	Cobb Douglas, CES	Time Series 1959 - 1992	Output 0.06 - 0.07	Yes

Table 4.1 continued.

Study	Type of Study	National / Regional	Sectors	Functional Form	Time-Series / Cross-Section / Panel	Elasticity	Significant
Ram (1986)	Empirical	Cross Country		'Cobb Douglas'	Cross Section Time Series, 1960 - 1980	Marginal Externality -1.41 to 0.5	Find spillovers
Ram & Ramsey (1989)	Empirical	National, USA	Private Output	Cobb Douglas	Time Series, 1948 - 1985	Output 0.24	Yes
Ratner (1983)	Empirical	National, USA		Production Function, Cobb Douglas	Time Series 1949 - 1973	Output 0.06	Yes
Rietveld & Boonstra (1995)	Empirical			Supply			
Rovolis & Spence (1999)	Empirical	National, Regional, Greece	Manufacturing & Non-Manufacturing Sectors	Cobb Douglas	Time Series, Panel 1982 - 1991	Output Non Man. Sectors: -0.15 to 0.36 Man. Sectors: 0.65 to 0.89 Regions: 0.04 to 0.38	Yes (lots of results)
Seitz (1993)	Empirical	National, Germany	31 Manufacturing Industries	Cost Function, Input Demand Functions, Generalise Leontief	Panel, 1970 - 1989	Cost: -0.0003	Yes
Seitz (1994)	Empirical	National, Germany	31 Manufacturing Industries	Cost Function, Factor Demands, Generalised Leontief	Panel, 19770 -1989	Shadow Price: 0.003 to 0.004 Factor Demand: L -0.01 to -0.29 K 0.7 to 0.82	Yes

Table 4.1 continued.

Study	Type of Study	National / Regional	Sectors	Functional Form	Data	Elasticity	Significance
Seitz & Licht (1995)	Empirical	Regions, German States		Cost Function, Translog	Panel 1971 -1988	Cost: -0.1 to -0.35	Yes
Shah (1992)	Empirical	National, Mexico	3 Digit Industries	Cost Function, Input Demand, Translog	Time Series, Pooled, 1970 - 1987	Rate of Return 0.05 to 0.07	Yes
Sturm et.al (1996)	Review, Empirical	National, Netherlands		Production Function, Cobb Douglas	Time Series, 1953-1991	0.51 - 1.13	Yes
Vijverberg et.al (1997)	Empirical	National, USA	Non Financial Corporate Sector	Production, Cost and Profit Function, Cobb Douglas, Semi-Translog	Time Series, 1958 - 1989	inconclusive	
Wylie (1996)	Empirical	National, Canada	Manufacturing	Production Function Cobb Douglas, Translog	Time Series 1946 - 1991	0.248 - 0.407	Yes

II.4.3 Human Capital

The debate on the effect of human capital on aggregate output and growth is still ongoing and no clear consensus has emerged yet. This is despite the fact that at the individual level the returns to schooling have been found to be positive and statistically significant (see Harmon and Walker, 1995 or Barrett, Callan and Nolan, 1999).

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

In an influential paper Mankiw, Romer and Weil (1992) found using a cross country data set that the output elasticity with respect to human capital as measured by the secondary school enrolment rates is in the region of 0.3. This work has been extended by Nonneman and Vanhoudt (1996), who find that elasticity to be somewhat smaller at 0.15. Further corroborating evidence for this result has been put forward by Demetriades, Arestis and Kelly (1998), who, using mean years of schooling as a proxy for human capital, find the output elasticity to be 0.37.

Griliches and Regev (1995) use a labour quality index which is based on the mix of academic qualifications in the labour force in a study of firm productivity in Israeli industry. These authors find the elasticity of output per worker with respect to labour quality to fall in the range between 0.14 and 0.74.

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

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

This brief review indicates that on balance human capital is likely to have a positive impact and that the output elasticity is in the range of 0.15 to 0.4. However there appears to be scope for further work in this areas. In particular the existing literature has yet to address the issue of spillovers of human capital as there has been no attempt to estimate the productivity effect of the presence of a highly educated worker on a worker who with lower human capital.

II.4.4: Measuring human capital

If one is to study the relationship between human capital and growth, it is necessary to have a methodology for measuring the level or the flow of human capital. In most studies in this area a simple approach is adopted that does not distinguish between the level at which the education takes place (see Sianesi and Van Reenen, 2002 for a comprehensive survey). In such approaches, years spent in education are simply counted and years in primary school are treated in the same way as years spent in university. This simplification is often necessitated by the unavailability of data for many countries. However, in the case of many of the countries covered in the HERMIN models of the COHESION system, reliable and comparable data are collected annually by the OECD, together with a common classification of different types of education.

In order to measure the impact of that proportion of the EU cohesion policy funding that were, or are to be, devoted to the development of human capital, the starting stock of human capital is needed. Since the ex-post evaluation is focused on the period 2000 to 2013, this starting stock is needed for the year 1999.

The most basic variable that is required to measure the stock of human capital is the educational attainment of the population. This simply records the percentage of the population by their highest level of attainment. The breakdown chosen by the OECD refers to four levels of educational attainment:

i. Primary and lower secondary education (PS)
ii. Higher secondary education (HS)
iii. Non-university tertiary education (NUT)
iv. University education (UT)

Primary and lower secondary education are grouped together since these are the most basic levels of education and lower second level education tends to be the minimum level of education at which children leave school. Table 6.2 shows that there were large differences between many of the EU states by the middle of the last decade. For example, Portugal has a very high percentage of the population in the primary and lower secondary group and consequently only small percentages in the higher groups. The opposite is true for Germany.

Table 4.2: Educational Attainment:
Percentage of population classified by highest level of attainment (1994)

	Primary and Lower Secondary	Higher Secondary	Non University Tertiary	University Tertiary
Greece	55	27	6	12
Ireland	55	27	10	9
Portugal	81	8	3	7
Spain	74	11	4	11
Germany	16	62	10	13
Italy	67	26		8
UK	26	54	9	12

Source: OECD Education at a Glance, 1996

Table 6.2 refers to the whole population and ignores generational differences. In order to further evaluate these differences, it is useful to analyse the educational attainment of persons aged 25 to 34 years. This also yields a more accurate picture of the likely future development of human capital. Table 6.3 shows particularly low rates of attainment in Portugal, Spain and Italy.

Table 4.3: Educational attainment:
Percentage of the population aged 25 to 34
which has attained at least upper secondary or third level education, 1995

	Upper Secondary and Higher	Tertiary education
Greece	64	26
Ireland	64	27
Portugal	31	14
Spain	47	27
Germany	89	21
Italy	49	8
UK	86	23

Source: OECD Education at a Glance, 1997

The usual measure of human capital in the economic literature is years of schooling. However, this variable ignores the important differences between the educational systems of the countries in question, and this can introduce biases into the measure of human capital. Table 6.4 highlights these difference by giving details of the typical cumulative years of schooling required to complete a particular level. For example, in order to complete lower secondary level education, a pupil in Ireland, Spain and Germany will spend 10 years in school, while students in Portugal and Italy require just 8 years. The table also shows the additional years that are required to attain the next highest level of education which can be readily worked out by subtracting the years required for the lower level from the years required for the higher level. It should be noted that the University level does not build on the non-university tertiary level, rather both tertiary levels tend to be at the same time by different non-overlapping groups, and build on the higher secondary levels.

Table 4.4: Cumulative years of schooling required to attain a specified level of education (1994)

	Primary and Lower Secondary	Higher Secondary	Non University Tertiary	University Tertiary
Greece	9	12	15	23
Ireland	10	13	15	16
Portugal	8	12	14	16
Spain	10	12	14	17
Germany	10	13	15	19
Italy	8	13	13	20
UK	9	13	15	16

Source: OECD Education at a Glance, 1996

A further issue that arises is the fact that the participation in the labour force is not equal for all levels of educational attainment. As is obvious from Table 6.5 below, persons with a lower level of education are less likely to participate in the labour force than those with a higher level of education. This clearly reflects the fact, that those with a higher level of education have invested more in their education and are therefore seeking a return to their investment as well as the fact that these individuals also tend to have more opportunities to gain employment since their skill are more in demand. Of course this also means that a given programme that increases the human capital of individuals will not result in all individuals finding employment or even seeking employment.

Table 4.5: Labour force participation by educational attainment (percentage, 1994)

	Primary and Lower Secondary	Higher Secondary	Non University Tertiary	University Tertiary	Total
Greece	62	67	84	87	67
Ireland	58	73	85	89	67
Portugal	72	84	87	95	75
Spain	58	80	88	87	65
Germany	56	76	85	88	75
Italy	58	73	85	89	67
UK	64	82	87	91	79

Source: OECD Education at a Glance, 1996

II.4.5 The role of R&D

The main source of parameter values for spillovers due to R&D is a recent report of the US Congressional Budget Office (*R&D and Productivity Growth*, Background Paper, Congress of the United States, June 2005. This review paper examines how investment spending on research and development influences economic growth and evaluates how these effects should be incorporated into the CBO medium term macro model.

The main evidence surveyed relates to econometric estimates of the elasticity of output with respect to R&D. The paper finds some evidence that there is a link between R&D and productivity growth, with a rate of return at least equal to the return on other types of investment. However, it is difficult to identify the magnitude of the effects with any degree of precision. Results span a wide range, and depend on the data sample, the estimating method and the period being covered.

The empirical evidence is strongest in cross-sectional studies, and weakest from time series studies. There is also evidence of inter-sectoral spillovers.

The relative weakness of the evidence suggests that one should use conservative values for R&D spillover elasticities, pending more robust empirical research. However, to ignore the effect would be a mistake. In the EC Cohesion Policy programmes of investment, the sums allocated to R&D are quite modest compared to the sums allocated to physical infrastructure and to human resources. By taking elasticities at the lower end of the international spectrum, we avoid exaggerating the possible links.

Annex III: A PowerPoint exposition of the Cohesion Policy impact methodology

Analysis of the impact of cohesion policy

The HERMIN-based simulations

Some preliminary remarks

a) The analysis of CP impacts has proved controversial; there is no consensus on results
b) It is important to set out the main "phases" of analysis, and to isolate any aspects that may be dominating the results
c) The concept of "impact" of CP is itself a complex issue, and needs to be "unpacked"
d) An effort should be made to agree a common approach to macro evaluation methodology, where there is no controversy
e) Important not to neglect a parallel micro-evaluation approach, which may shed light on the macro controversies.

Three key phases of Cohesion Policy (CP) macro impact analysis

Phase 1:
Developing an appropriate macro CP methodology

Phase 2:
Preparing the CP intervention data

Phase 3:
Quantifying CP impacts

Phase 1
Developing an appropriate macro CP methodology

a) What macro-model to use?
b) The CP transmission mechanisms inside the model
c) How strong are the CP transmission mechanisms: spillovers and externalities
d) Using a macromodel to quantify CP impacts
e) The nature of the no-CP counterfactual

Phase 2:
Preparing CP intervention data

a) The nature of “raw” CP investment data

b) Transforming CP investment data from Operational Programme classification to “economic” classification

Phase 3:
Quantifying CP impacts

a) Presenting the CP impact results

b) CP impact evaluation in a wider context

Phase 1
Developing an appropriate macro CP methodology

a) What macro-model to use?

Fact: Macro impact evaluation requires models

Fact: There is no "consensus" model

Fact: Different models produce very different results

Fact: The economies of the NMS have not yet been much exposed to modelling, particularly on the supply side

Fact: Data in the NMS are in short supply (1995-2005),

Fact: Over this 11-year period, the NMS economies have been restructuring dramatically

Conclusion: It would be unwise to be dogmatic about the appropriate model for the NMS. Careful experimentation is needed, drawing on best possible data sources.

The revised versions of the HERMIN model try to address some of these concerns

i. A uniform database for 1995-2005 has been assembled from Eurostat and national sources
ii. Sectoral disaggregation on the production side (manufacturing, market services, building & construction, agriculture and government) attempts to examine structural changes taking place
iii. The model does not assume perfect foresight or complete optimizing behaviour of agents in the household sector
iv. Cross-country comparisons are made in an effort to "standardise" model behaviour, where necessary

What is HERMIN?

A "neo-Keynesian model whose designed structure permits the possibility that the NMS economies are:

i. Operating at less than full capacity;
ii. Markets do not always clear;
iii. Expenditures incurred as the CP is implemented will have positive transitory demand impacts as well as positive post-implementation supply-side impacts;
iv. Implementational demand impacts are likely to be (mildly) inflationary;
v. CP termination will inject transitory deflation

b) The CP transmission mechanisms inside the model

The CP-financed investments are assumed to drive three stock accumulation processes

i. Physical infrastructure (PI)
ii. Human capital (HR)
iii. Research and Development (R&D)

Serious methodological challenges

- Ex-ante impact analysis of "yet-to-be-implemented" CP programmes
- Is the CP design appropriate? How effective will be the implementation?
- Strict monitoring and evaluation can help, but do not guarantee success

Physical infrastructure: PI

- Demand-side impacts (implementation):

  PI → IG → I (total investment)
  → (Keynesian multiplier)
  → impact on GDP

- Supply-side impacts (mainly post-implementation):

  PI → increased stock of infrastructure (KPI)
  → boost to output/productivity in T, M

Human resources: HC

- Demand-side impacts (implementation):

  HC → Income & Public expenditure
  → Keynesian multiplier
  → GDP

- Supply-side impacts (mainly post-implementation):

  HC → stock of human capital (KHC)
  → boost to output/productivity in T and M

Research and Development

- <u>Demand-side impacts (implementation)</u>:

  R&D → I (total investment)
  → (Keynesian multiplier)
  → impact on GDP

- <u>Supply-side impacts (mainly post-implementation)</u>:

  R&D → increased stock of R&D (KRD)
  → boost to output/productivity in T and M

Serious methodological challenges: continued

- The links between infrastructure, human capital and R&D are difficult to measure.
- A parallel improvement in all three is probably necessary
- But we cannot say much about the optimum balance between them within an integrated CP programme
- Further links to other policies are unclear (e.g., Single Market, EMU, FDI, etc.)

c) How strong are the CP transmission mechanisms: spillovers and externalities

i. The international literature has produced a very wide spectrum of impact magnitudes for CP-like investments

ii. We take values that are close to the mid-range of international estimates

iii. Common values imply similar degree of CP optimality and local institutional capacity

Default values of spillover parameters

	Manufacturing output	Manufacturing productivity	Market Services output	Market Services productivity
Physical infrastructure	0.20	0.10	0.03	0.03
Human resources	0.10	0.10	0.03	0.03
R&D (APS)	0.03	0.03	0.03	No spillover effect

d) Using a macromodel to quantify CP impacts

i. Project all non-CP exogenous variables out to the year 2020 (world, domestic policy instruments, etc.)

ii. Set all CP instruments to zero (in the case of a "zero" counterfactual)

iii. Simulate model out to 2020

iv. Re-set CP instruments to appropriate values

v. Re-simulate model to 2020

vi. Compare (i) to (g), to evaluate CP impacts

e) The nature of the no-CP counterfactual

A range of different no-CP counterfactuals are possible

The "zero substitution" case:

Domestic authorities do not substitute with domestic finance, and cancel the entire investment programme (default)

The "full substitution" case:

Domestic authorities fully implement original CP investments, but financed entirely out of own resources

The "partial substitution" case:

Domestic authorities implement only part of the original CP investments, but financed out of own resources

Implications of the choice of counterfactual

Zero substitution: Impact analysis would attribute to the CP the entire economic benefits of the CP investments, treating the funding as a grant

Full substitution: Impact analysis of this case would be identical to the "zero substitution" case, except for the negative impacts (such as higher tax rates or offsetting cuts in expenditure) of the need to finance domestically

Partial substitution: This case is difficult to evaluate. If the cancelled CP investments were genuine barriers to growth, the outcome might fall well below "full substitution". If the cancelled CP investments were poorly designed (high deadweight/crowding out), then this case might be actually better than "full substitution".

Phase 2:
Preparing CP intervention data

a) The nature of "raw" CP investment data

i. These data are supplied by DG-REGIO

ii. It should be kept in mind that they are planned expenditures, and the actual phasing may differ from the planned phasing

iii. The data are organised into Operational Programmes, and each OP can have a mixture of investment type

iv. Before these data can be used for impact modelling, they have to be re-classified into economic categories

b) Transforming CP investment data to "economic" categories

i. The re-classification of the CP data from OP format to economic format is carried out by specially written spreadsheet files (computer demonstration)

ii. The three main economic classifications are physical infrastructure (PI), human resources (HR) and direct aid to productive sectors (APS).

iii. Within APS, we further separate R&D investment from other direct aid.

Estonia: Case B

CP data in economic classification

	A	B	C	D	E	F	G	H	I	J	K
1	CASE A	Planned figures									
2											
3		GECSFEC_E	ZZEUR*	RDPCOFIN	RPRCOFIN	RIGVCSFE	RGTRSF	RTRIT	RTRIM	RRDTCSF	RTRIA**
4	2000	0		0	0	0	0	0	0	0	0
5	2001	0		0	0	0	0	0	0	0	0
6	2002	0		0	0	0	0	0	0	0	0
7	2003	0		0	0	0	0	0	0	0	0
8	2004	54.6		0.00	0.00	50.13	38.88	70.59	29.41	36.09	0.00
9	2005	76.6		0.00	0.00	50.13	38.88	70.59	29.41	36.09	0.00
10	2006	139.3		0.00	0.00	50.13	38.88	70.59	29.41	36.09	0.00
11	2007	277		0.00	0.00	50.13	38.88	70.59	29.41	36.09	0.00
12	2008	444		0.00	0.00	50.13	38.88	70.59	29.41	36.09	0.00
13	2009	370		0.00	0.00	50.13	38.88	70.59	29.41	36.09	0.00
14	2010	399		0.00	0.00	50.13	38.88	70.59	29.41	36.09	0.00
15	2011	433		0.00	0.00	50.13	38.88	70.59	29.41	36.09	0.00
16	2012	417		0.00	0.00	50.13	38.88	70.59	29.41	36.09	0.00
17	2013	415		0.00	0.00	50.13	38.88	70.59	29.41	36.09	0.00
18	2014	571		0.00	0.00	50.13	38.88	70.59	29.41	36.09	0.00
19	2015	583		0.00	0.00	50.13	38.88	70.59	29.41	36.09	0.00
20	2016	0		0	0	0	0	0	0	0	0
21	2017	0		0	0	0	0	0	0	0	0
22	2018	0		0	0	0	0	0	0	0	0
23	2019	0		0	0	0	0	0	0	0	0
24	2020	0		0	0	0	0	0	0	0	0

Phase 3: Quantifying CP impacts

a) Presenting the CP impact results

i. These results have already been presented in Tables 1-14 of the written report (refer to report)

ii. The generation of the results can be illustrated by actual computer simulations.

iii. Case study (on computer): Estonia
   a) The baseline (no-CP) projection
   b) Simulating CASE A
   c) Simulating CASE B

Measuring CP impacts: annual versus cumulative

- Annual impacts refer to specific years, and can be used to measure convergence (refer graph)
- Cumulative impacts refer to summation over a specified time period, and can be used to measure rates of return (refer graph)

Ordinary policy multiplier
(at time t)

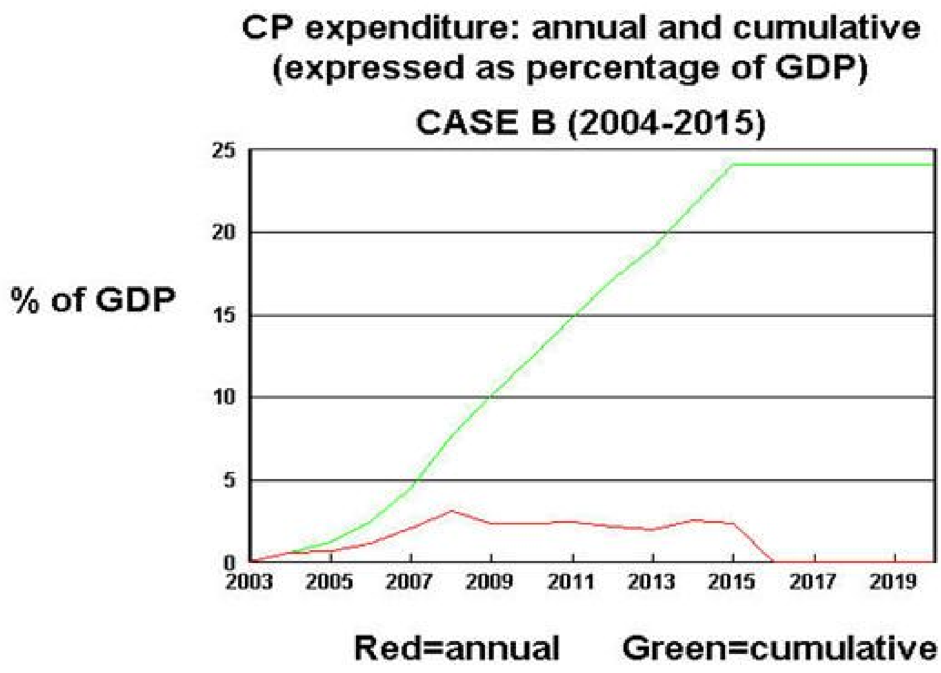
Change in GDP

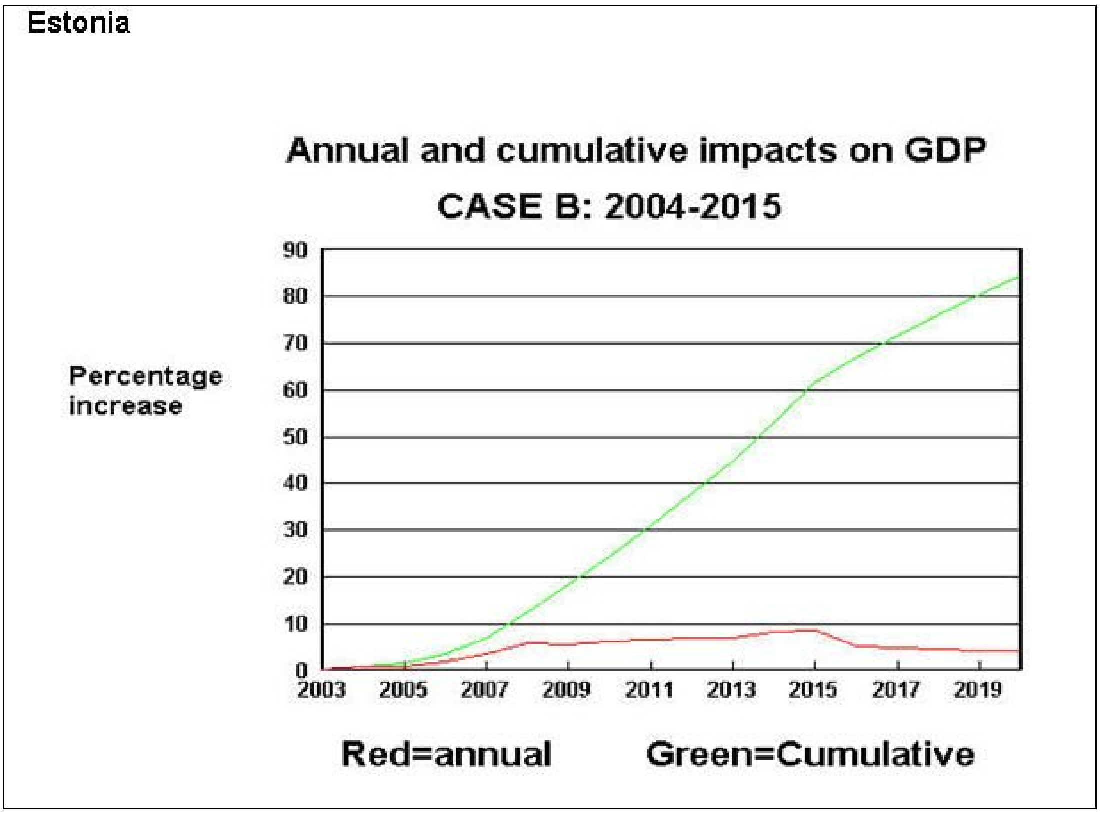
Change in public investment

Cumulative policy multiplier
(between t and t+n)

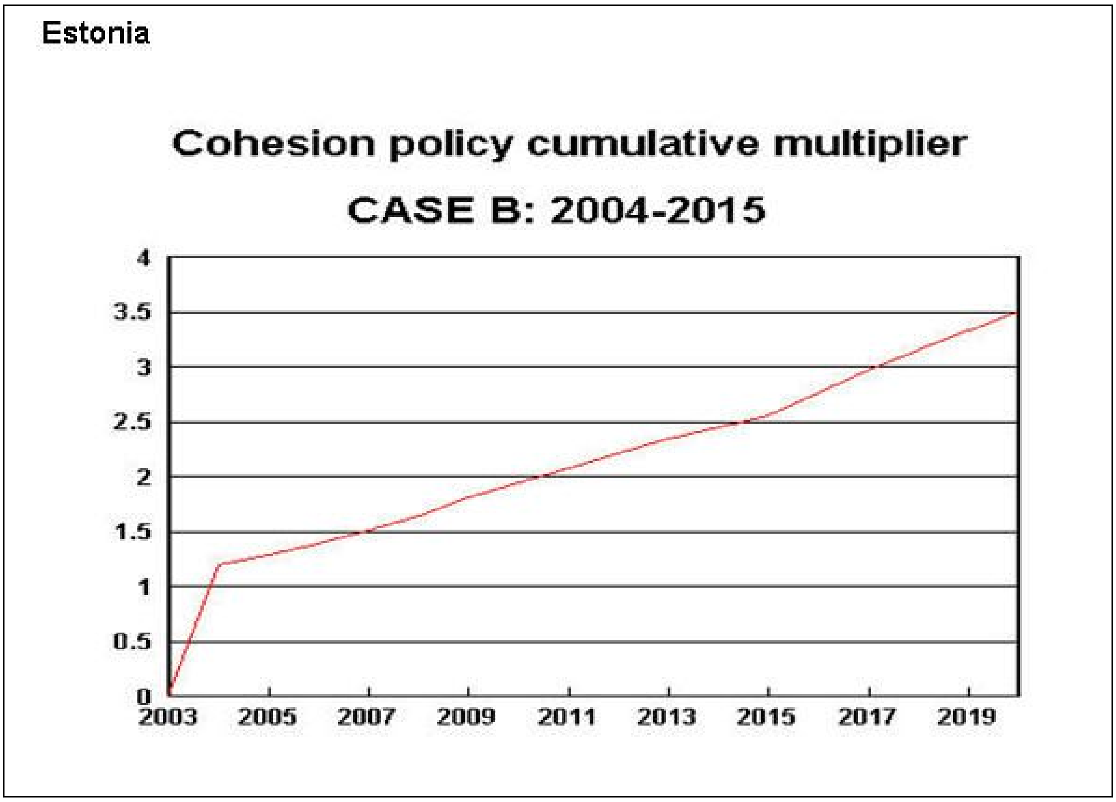
Cumulative percentage change in GDP
--
Cumulative percentage share of CP in GDP

Estonia





Estonia
Annual and cumulative impacts on GDP
CASE B: 2004-2015
Percentage increase
90
80
70
60
50
40
30
20
10
0
2003
2005
2007
2009
2011
2013
2015
2017
2019
Red=annual
Green=Cumulative



Estonia
Cohesion policy cumulative multiplier
CASE B: 2004-2015
4
3.5
3
2.5
2
1.5
1
0.5
0
2003
2005
2007
2009
2011
2013
2015
2017
2019

Discussion of impact results

CASE A and CASE B: Different time profiles of CP expenditure

1) CP expenditure as percentage of (ex-post) GDP
2) Cumulative CP expenditure as percentage of (ex-post) GDP
3) Annual percentage increase in level of GDP due to CP
4) Cumulative percentage increase in level of GDP due to CP
5) Cumulative CP multiplier
6) Impact on GDP and employment, in 2013
7) Impact on GDP and employment, in 2015

b) CP impact evaluation in a wider context

i. The model-based analysis can be characterised as a theory of action, to use MEANS terminology (see diagram me)
ii. It is important to consider the CP impact analysis in a wider context of the other forces that are driving convergence in the NMS (or, an explanatory theory, to use MEANS terminology)
iii. Such forces include industrial strategy, integration into the Single Market, euro-zone stability, and a range of internal structural reforms along the lines of the Lisbon Strategy

Theory of action:

Effects / Causes	Economic and social cohesion	Other effects
Structural Funds	Theory of action	
Other policies and all other external causes		

Explanatory theory

Effects / Causes	Economic and social cohesion	Other effects
Structural Funds	Explanatory Theory	
Other policies and all other external causes		