A STUDY OF THE MACRO-ECONOMIC IMPACT OF THE REFORM OF EU COHESION POLICY

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[1] Introduction

This study was carried out in the context of EU enlargement and preparation for the next (post-2006) round of expenditure on cohesion policy. The countries/regions involved in the analysis are three of the original four "cohesion" countries (Greece, Portugal and Spain); the two present Objective 1 "macro-regions" in Germany and Italy; the ten new member states; and two candidate countries (Bulgaria and Romania).[1]

The Commission has provided us with an indicative overall level of total expenditure to be envisaged for *Objective 1* (now renamed *Convergence Priority*) and the *Cohesion Fund* following the envisaged reforms, as well as its duration and its breakdown across the countries involved. These data are discussed further in Section 2 below.

The purpose of the study is to set out a modelling framework of cohesion policy (HERMIN), and to carry out an analysis of the impact of proposed convergence and cohesion policy expenditure on the main macro-economic variables in the beneficiary countries and regions, compared to various counter-factual situations. The counter-factuals were to be as follows:

i. For the current main beneficiaries:

   a) The main counter-factual baseline: zero community intervention;
   b) A second counter-factual baseline: the existing (CSF 2000-2006) level of expenditure.

ii. For the new member countries and the two candidate countries:

   a) Counter-factual baseline: zero community intervention.

The main macroeconomic variables upon which impacts are to be assessed include: GDP, total employment, labour productivity, and unemployment.[2] In addition, a range of other relevant variables deriving from the HERMIN model structure (see Section 3) are reported, in order to build up a comprehensive assessment of convergence and cohesion policy impacts. Furthermore the effects on the environment as well as the effects on trade are examined in a broader circle of countries.

An important element of the study was that a clear distinction must be made between the short-run demand effects of convergence and cohesion policy expenditures (i.e., the effects generated during the implementation of the actual policy programmes) and the longer-run supply-side effects (i.e., the effects that become manifest mainly after the investment expenditures have ceased on the completion of the policy programmes, and when beneficial effects flow from improved stocks of physical infrastructure, human capital and productive capacity). To ensure such a distinction, it is necessary to present model simulation results for some 10-15 years into the future, both in terms of intermediary impacts and in terms of the cumulative total impact.

[1] Ireland was an Objective 1 and cohesion country under CSF 1989-93, CSF 1994099 and CSF 2000-2006. However, because of its rapid convergence, it is excluded under CSF 2007-13.
[2] Where labour markets are closed, and labour supply inelastic, the impact on unemployment is simply the negative of the impact on employment.

An indicative breakdown of spending for the current programming period (2000-2006) was provided by the Commission, and the scenarios in (i) and (ii) above were discussed between us and the Commission, using the current (CSF 2000-2006) funding breakdown as a point of departure for the next (2007-2013) programming period. The data used are further described in Section 2 below.

This report was intended to describe a series of simulated scenarios that address the following issues:

i. The differing impact of convergence and cohesion expenditure on countries and regions depending on its overall composition across broad investment categories (e.g., physical infrastructure, human resources and aid to the productive sectors), in order to investigate the role of spill-over effects;

ii. The underlying aim of identifying high and low spill-over scenarios, depending on the composition of expenditure. Consequently, a sensitivity analysis was required (to be described in Section 6);

iii. Given that there is a body of previous work on CSF impact evaluation, the report was to provide a short summary of this research, and relates the earlier findings to the new analysis of the period 2007-2013. This material is included in Section 4, as part of the description of the model-based methodology for impact analysis.

Since national (i.e., non-cohesion) public expenditure plays a key role in supporting cohesion policy interventions, the scenarios attempt to comment on the sensitivity of cohesion policy impacts with respect to changes in the composition of national public (non-cohesion) expenditure. Such material is included in Section 6, as part of the wider sensitivity analysis.

The country specificities of the impact evaluation will be determined by the properties of the different country and regional models according to the individual countries, the specific parameters identified in the individual country models, as well as by the inputs provided in the data received from DG-REGIO. To some extent we try to control for impacts that are model-specific by adopting a broadly similar structure in the HERMIN frameworks. But the models can differ in a limited number of ways, and the parameters in the behavioural equations are also country-specific.

Two further issues are explored in the study:

<u>Trade effects</u>: As the convergence and cohesion policies generate increased demand (in the shorter term) and stimulate accelerated development (in the longer term), there are likely to be impacts on imports, exports and the balance of trade. While the policies are being implemented, during 2007-13, we anticipate that imports will be stimulated more than exports, relative to the baseline (i.e., the no-CSF) scenario. But after the policies are complete, post-2013, there is a likelihood that the improved supply-side performance (relative to the baseline) will reverse this. The effects on trade are investigated, including an assessment of which EU member "donor" countries are likely to gain most from the increased intra-EU trade that is stimulated by the CSF.

<u>Environmental effects</u>: A general assessment is made of the potential environmental effects of the development path that arises as a result of convergence and cohesion policy, addressing

such issues as the energy intensity of production, air and water pollution levels, etc. Since we do not yet have explicit quantitative environmental sub-models in HERMIN, we carry out a general investigation of environmental impacts, drawing on the recent literature.

The rest of the report is organised as follows:

In section 2 we present and discuss the Convergence and Cohesion Fund expenditure data projections made available to us by the Commission for the purposes of exploring possible impacts of a new round of *Convergence Priority* and *Cohesion Funds* for the period 2007-2013.

In section 3 we provide a brief overview of the structure and properties of the various HERMIN national and regional models used in the project. The purpose of this section is to alert the reader to some of the more important properties of the HERMIN models insofar as they influence Structural Fund impacts.

In section 4 we provide a short description of the policy modelling methodology used to evaluate the impacts of *Convergence Priority* and *Cohesion Funds*. This approach uses the HERMIN model framework, and attempts to handle explicitly the way in which the funds are designed to alter the structure and performance of recipient economies. The appendix to section 4 contains a compact summary of the international research findings on the role of physical infrastructure and human capital in promoting growth and convergence.

In section 5 we present the analysis of the impacts of the 2007-2013 *Convergence Priority* and *Cohesion Funds*, based on a "central" assumption with respect to funding allocations to the main economic categories (i.e., physical infrastructure, human resource and direct aid to the productive sectors) as well as a "central" assumption of specific values for the important "externality" elasticities through which the longer term supply-side policy impacts occur. These "central" assumptions are selected to represent the most likely findings from the international literature, and are designed to capture the supply-side impacts of investment programmes that are designed and implemented according to the average of these findings.

In section 6 we present a sensitivity analysis with respect to the important "externality" elasticities that determine the long-run impacts. We also discuss the likely sensitivity to funding allocations within the three main economic categories (physical infrastructure, human resources and direct aid to the productive sectors). What we are trying to address here is the fact that we cannot say *ex ante* if a CSF will be designed and implemented in an optimal fashion. So, the low externality elasticities are broadly representative of a "poorly" designed CSF, while the high values are broadly representative of a "well" designed CSF.

In section 7 we discuss a range of issues related to trade and the *Convergence Priority* and *Cohesion Funds*, i.e., the impact of the funds on the trade balance, and the likely beneficiary countries. We implement a computational schema that attempts to quantify the trade spill-over effects from the recipient countries, based on the output and net trade impacts on these recipient countries.

In section 8 we discuss the likely environmental impacts of the *Convergence Priority* and *Cohesion Funds*. This has to be a somewhat simple evaluation, since none of the HERMIN models have explicit environmental modules, and the environmental aspects raise many complex issues that simply cannot be handled with the existing knowledge base, or in the very short time frame (two months) and modest resources of this project.

Section 9 concludes, and summarises the main findings. There is a bibliography of literature sources related to the topics treated in the report.

[2] Data for cohesion analysis: 2007-2013

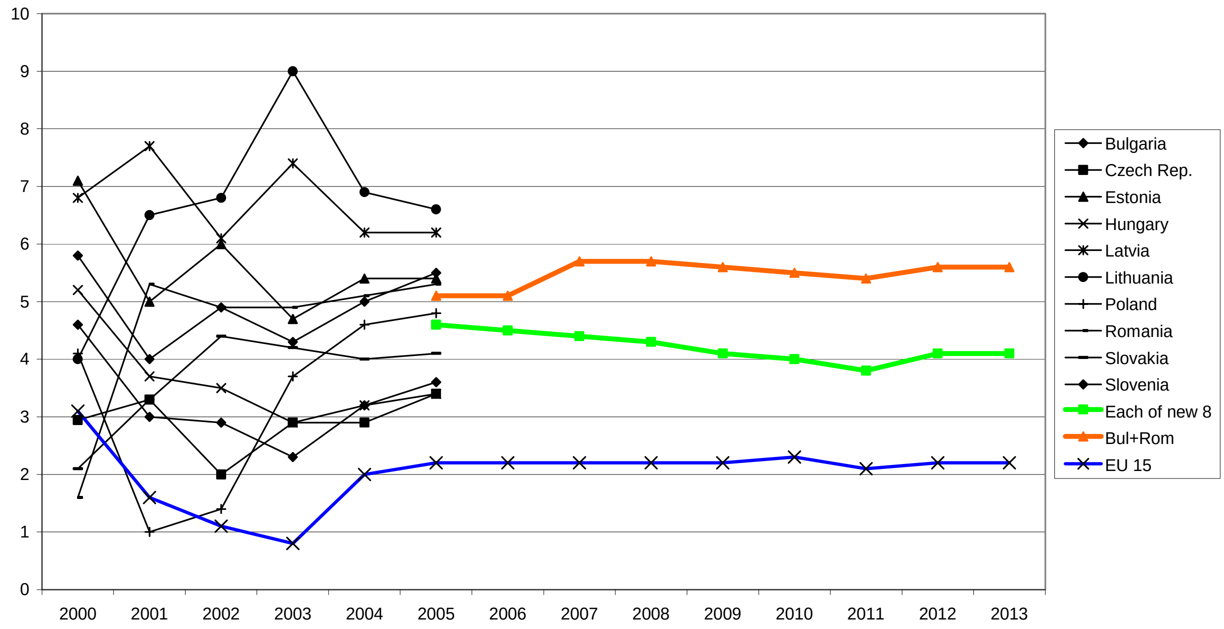
2.1 Baseline growth forecasts for 2004-2013

The DG-ECFIN long-term forecasts for GDP growth for 2005-2013 in the "old", "new" and "candidate" states were made available to us. These forecasts include uniform growth rates for the old members states of EU 15, for the 10 new member states, and the acceding countries of Bulgaria and Romania. These forecasts, along with the past growth rates for the individual countries and EU 15, are summarised in the graph below (Figure 2.1). It is seen that Bulgaria and Romania are projected as having a higher common rate of growth than the new member states. This may be unrealistic, given that these two countries were not the best performing economies of the candidate states during the past decade.

We may assume that this growth forecast has been based on the absolute convergence hypothesis since Bulgaria and Romania are the least developed of the ten Central and East European Countries today. But this condition may be overemphasized , given that Latvia and Lithuania are not that much more developed than Bulgaria and Romania. A possible explanation for the large difference between the two uniform growth rates of the Central and East European countries could be that the DG-ECFIN forecasts may already (even implicitly) take into account the beneficial effects of an anticipated wave of foreign direct investment to Romania and Bulgaria, but may not take into account the beneficial effects of the *Convergence Priority* and *Cohesion Funds* for the eight new member states from the region. In any case, what is clear that these forecasts, either by necessity or for political or other considerations, appear to be highly simplified, and therefore their value for our modelling exercise is somewhat limited.

Figure 2.1

GDP growth rates, past and forecasts, percent



Source: until 2004: Gacs and WIIW, 2005: Comm. Spring Forecasts; 2005-2013 Comm. Forecast

2.2 Allocation of EC funding for 2007-2013

To carry out the *ex-ante* analysis of the impacts of the proposed reform of the cohesion and convergence funds, the following information was needed:

i. The total projected level of cash input by the European Commission; and

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

2.2.1 The total level of cash input by the European Commission

The data provided by DG-REGIO propose an initial total cash input by the Commission, allocated across each Member State, for 2007-2013. This allocation is made to states and regions that were previously designated by the term "Objective 1". The financial allocations are now designated under two headings: the *Convergence Priority* (previously termed the Structural Funds) and the *Cohesion Fund*.

Overall funding for the *Cohesion Funds* and *Convergence Priority* after the year 2006 will necessarily be linked to the final overall EU budget for the period 2007-2013, which is currently being negotiated. The overall budgetary package for the period 2007-2013 is referred to as the *Financial Perspectives*, and the Commission's current proposal for the overall *Financial Perspectives* is set at 1.14 per cent of EU GNI (basically GNP).

The cash figures that emerged from the initial calculations within the Commission will eventually be negotiated formally in the Council of Ministers. Hence, the financial data used in this report should be regarded as very tentative, and are being used merely to permit us to proceed with the quantitative analysis of *ex-ante* impacts. The projected cash amounts for the *Convergence Priority* (*CP*) and the *Cohesion Fund* (*CF*) combined are expressed in constant 2004 prices. In the absence of any firm forecasts, it is assumed that all exchange rates against the euro are stable from the year 2004.

The cash amounts being used within DG-REGIO for planning purposes are only for the EC element of the expenditure on the *CP* and *CF*. To this must be added a domestic co-financing element, which will be a charge on the domestic budgets of each recipient country. The working assumption made is that the EC element will be 60 per cent of the total, and the domestic co-financing element will make up the remaining 40 per cent. Thus, the domestic co-financing rate is assumed to be 40 per cent.

2.2.2 Composition of expenditure

The following assumptions are made in allocating the *CP* and *CF* expenditures over the three main economic categories. First, for the next *CP* and *CF* programme, neither fund will cover rural development, so this element is excluded. Second, the *CF* (which is all infrastructure) will in future account for one third of cohesion policy interventions in the new member states, and one fifth in the others. But Germany, Italy and Spain will not be eligible for *CF* at all.

As a point of departure, the existing breakdown from Operational Programmes (OPs) in the current (2000-2006) programming period was taken, since this provides the best indicator available for the likely future breakdown. For the “new” member states, these were based on the 2004-2006 programme, which will start up soon after the May accession of the ten new member states. For the "old" member states, the distribution incorporated within the 2000-2006 programme was used, as published in the third cohesion report (*A New Partnership for Cohesion*, 2004).

The breakdown naturally differs between member states, since the design of the Operational Programmes is country specific, within fairly broad constraints. The designation of expenditure under the headings of infrastructure, human resources and aid to the productive sectors is usually straightforward, since the Operational Programmes are usually focused into one or other of these three specific categories. The distribution of any "Integrated Regional Operational Programmes", which are in place during 2004-2006 in three of the new member states, was more difficult, since they involve a mixture of the three main economic categories. Here, an approximate allocation was used. However, the *Cohesion Fund* was always assumed to consist entirely of infrastructure investment. The EC financial allocations prepared internally by DG REGIO are presented in Table 2.1.

Table 2.1: Projected expenditure on *CP* and *CF*
(2004 prices, million euro: EC expenditure only

Country	2007	2008	2009	2010	2011	2012	2013
Group 1: "Old" member states with HERMIN models							
EL	3425	3425	3376	3326	3276	3227	3177
E	3514	3514	3493	3471	3450	3429	3408
P	2803	2803	2798	2792	2786	2781	2775
Group 2: Macro-regions of "old" member states with HERMIN models							
D	2112	2112	2065	2018	1971	1924	1877
I	2797	2797	2793	2789	2785	2781	2777
Group 3: New (2004) member states with HERMIN models							
CZ	3148	3275	3402	3530	3657	3795	3936
EE	310	322	334	346	358	371	384
HU	2698	2859	3031	3217	3416	3543	3672
LV	365	379	393	407	421	437	452
PL	7788	8090	8390	8694	8995	9324	9657
SI	639	639	639	639	639	639	639
Group 4: New (2004) member states without HERMIN models							
CY	13	13	13	13	13	13	13
MT	112	112	108	105	101	97	94
LT	669	695	722	749	775	804	833
SK	1153	1199	1244	1290	1335	1384	1434
Group 5: Candidate states with HERMIN models							
RO	1284	1738	2237	2351	2468	2594	2727
Group 6: Candidate states without HERMIN models							
BG	492	667	859	903	948	996	1048

In the sequence of tables that follow, we show the results of aggregating the individual national and regional *CP* and *CF* expenditures into the three economic categories: physical infrastructure, human resources and direct aid to the productive sectors. In every case, the three "shares" sum to unity.

Table 2.2 (a)

Group 1: "Old" member states with HERMIN models	
Greece	
Physical infrastructure	0.3798
Human resources	0.1559
Productive sector	0.4643
Spain	
Physical infrastructure	0.2820
Human resources	0.2336
Productive sector	0.4843
Portugal	
Physical infrastructure	0.4729
Human resources	0.1658
Productive sector	0.3614

Table 2.2 (b)

Group 2: Macro-regions of "old" member states with HERMIN models	
East Germany	
Physical infrastructure	0.4101
Human resources	0.3010
Productive sector	0.2889
Italian *Mezzogiorno*	
Physical infrastructure	0.4616
Human resources	0.1879
Productive sector	0.3505

Table 2.2 (c)

Group 3: "New" member states with HERMIN models			
Poland		Estonia	
Physical infrastructure	0.6205	Physical infrastructure	0.6537
Human resources	0.1864	Human resources	0.1766
Productive sector	0.1932	Productive sector	0.1698
Czech Republic		Latvia	
Physical infrastructure	0.5670	Physical infrastructure	0.6090
Human resources	0.2153	Human resources	0.1795
Productive sector	0.2177	Productive sector	0.2115
Hungary		Slovenia	
Physical infrastructure	0.6307	Physical infrastructure	0.5252
Human resources	0.1702	Human resources	0.2400
Productive sector	0.1991	Productive sector	0.2348

Table 2.2(d)

Group 4: "New" member states without HERMIN models			
Cyprus		Malta	
Physical infrastructure	0.5733	Physical infrastructure	0.3760
Human resources	0.2933	Human resources	0.1434
Productive sector	0.1333	Productive sector	0.4806
Lithuania		Slovakia	
Physical infrastructure	0.6038	Physical infrastructure	0.6615
Human resources	0.1256	Human resources	0.2211
Productive sector	0.2705	Productive sector	0.1174

Table 2.2(e)

Group 5: Candidate member states with HERMIN models	
Romania (distribution set same as Poland)	
Physical infrastructure	0.6205
Human resources	0.1864
Productive sector	0.1932

Table 2.2(f)

Group 6: Candidate member states without HERMIN models	
Bulgaria (distribution set same as Poland)	
Physical infrastructure	0.6205
Human resources	0.1864
Productive sector	0.1932

2.3 The analytical treatment of funding allocations

2.3.1 Introduction

As shown above, the data made available to us by DG-REGIO consist of time series for the total Community (EC) funding allocation to each recipient state, expressed in millions of euro at year 2004 prices. In each country/region, the notation used in the HERMIN model for these basic data is GECSFEC_RE, and they are given for the years 2007-2013 inclusive.[3]

The constant 2004 price data series GECSFEC_RE for each recipient country are converted to current prices (GECSFEC_E) by assuming a fixed inflation rate of 2 per cent per year from 2004 until 2013. For the new member states, these data must be converted into the local currency. The example below uses Hungary, where the euro/Hungarian exchange rate is defined as HUFEUR (260.04 per euro in 2002).

The domestic co-finance is derived from the DG-REGIO data using the assumed co-finance percentage of 60% (EC) and 40% (domestic public, or DP). The DP percentage (assumed to be 40%) is designated as RDCOFIN ("Rate of Domestic CO-FINance") in the formulae below.

The total (EC+DP) expenditure is then split between the three main economic categories (physical infrastructure, human resources and direct aid to the non-agricultural productive sectors). The national shares used, as provided by DG-REGIO, were based on the 2000-2006 period allocations, and were shown above in Tables 2.2(a)-(e). Note that the shares for Romania and for Bulgaria. were simply assumed to mirror those used for Poland, since neither Romania nor Bulgaria had participated in the 2004-2006 programmes in the same way as the "new" member states.

The further allocation of the Direct Aid to Productive Sectors (as between manufacturing, market services and Agriculture) is carried out using assumed shares, since these data were not provided by DG-REGIO. It was assumed for every case that 70 per cent of the Direct Aid to the productive Sectors went to manufacturing, with the remainder (30 per cent) going to market services.

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

2.3.2 Description in terms of analytic HERMIN model formulae

The EC total expenditure contribution for the years 2007 to 2013 is given by DG-REGIO in real 2004 euro as a datum (GECSFEC_RE). The constant price data is inflated to current prices (GECSFEC_E) by applying a 2 per cent per year inflation rate from 2004 to 2013, after which the funding is assumed to cease abruptly.[4]

$$GECSFEC\_E_{t+3} = GECSFEC\_RE_{t+3} * 1.02^{**(t-1)}$$

where t=1 in the year 2004.[5]

Where required, this is converted to national currency (GECSFEC) using exchange rate (e.g., HUFEUR (the number of units of Hungarian currency per euro in the case of Hungary).

$$GECSFEC = GECSFEC\_E * HUFEUR$$

The implied domestic (DP) co-finance contribution (GECSFDP) is derived by using a domestic co-finance ratio (RDCOFIN), assumed to be fixed at 40 per cent of total (EC and domestic) expenditure.

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

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

$$GECSF = GECSFEC + GECSFDP$$

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

i. Physical infrastructure (IGVCSF**)

ii. Human Resources (GTRSF**), and

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

where ** indicates a further breakdown into an EC (Community) or DP (Domestic Public) contribution.[6]

The percentage share going to physical infrastructure (IGVCSF**) is defined as RIGVCSF; and the share going to human resources (GTRSF**) is defined as RGTRSF. For simplicity, it

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[4] The abrupt and complete termination of all *CP* and *CF* activity after December 31, 2013 is an artificial and unrealistic assumption that we were obliged to make for the purposes of the present study.

[5] This somewhat complex formula takes account of the fact that the *CP* and *CF* expenditures are fixed in the year 2004 by DG-REGIO, and expressed in constant 2004 prices. Hence, if a notional inflation rate of 2 per cent per year from 2004 is assumed, the constant 2004 price expenditure (X) for the year 2007 (the first year of the new programme, and the year that the investment expenditures will actually take place) will become $X * 1.02^3$ by the year 2007.

[6] The notation used for the three main economic categories is as follows: IGV indicates public infrastructure investment; GTRSF indicates public sector transfers on ESF (Social Fund) activities; TRI indicates transfers to industrial (and service) sectors.

is assumed that the two shares (RIGVCSF and RGTRSF) apply both to the EC and the domestically co-financed components. The residual goes to direct aid to the productive sector (TRI**). This simplifying approach is used to facilitate the modelling, and replicates the allocation given in the DG-REGIO data.

Physical infrastructure:

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

Human resources:

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

Direct aid to the productive sectors:

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

Direct aid to the productive sectors (TRI**) is further disaggregated into its two sectoral allocations (manufacturing (T) and market services (N)).[7]

Manufacturing (percentage share = RTRIT):

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

Market Services (residual):

TRINEC = TRIEC - TRITEC
TRINDP = TRIDP - TRINEC

The above approach was adopted so that one could start with any given total allocation of EU funding to a recipient country, and could add in the domestic co-funding, as well as allocate this funding over the main economic categories in a simple fashion depending on a range of four pre-set parameters (i.e., the domestic co-finance rate (RDCOFIN); the proportion of total expenditure going to fund physical infrastructure (RIGVCSF); the proportion of total expenditure going to fund human resources (RGTRSF); and the proportion of direct aid to the productive sector going to manufacturing (RTRIT)).

[7] The sectoral notation T in HERMIN indicates the mainly Traded manufacturing sector. The notation N indicates the mainly Non-traded market service sectors. The two remaining sectors of the four-sector HERMIN model are Agriculture (A) and government services (G).

[3] The macro-sectoral structure of HERMIN models

3.1 Introduction

The estimation of the long-run impact of structural funds is more important than the estimation of their shorter-run Keynesian demand side impact, since the structural funds aim at changing the economic potential of an economy (the supply side) over the long run rather than to provide a short-run cash injection.[8] This limits the number of potential impact evaluation methodologies since not all are capable of capturing these long-run supply-side effects.

Another important limiting factor is that one model does not ideally fit all countries and regions. In other words, even the application of a common modelling framework, which is desirable in order to yield results that are comparable between countries, requires that the models should be adapted to each country or region. This implies that standardised models are less adequate and instead for each country/region the model coefficients and possibly the structure of the model need to be adjusted.

A range of different types of methodologies have been used for impact analysis of structural fund programmes. These include: case studies, I-O models, CGE models, single equation econometric models and multi-equation econometric models (see Ederveen *et al*, 2002(a) and (b) for review of some of the evaluation techniques).

For example, Beutel (2002) applies an input-output methodology to structural fund impact analysis at the macro-regional level (East Germany and the Italian *Mezzogiorno*) and at the national level (Greece, Ireland, Portugal and Spain). However, in addition to the problem of updating input-output tables, it is very difficult to incorporate supply-side (or neo-classical) adjustment mechanisms and feed-backs into an input-output framework (either static or dynamic).

Another regional modelling framework (REMI) is that of Treyz (1993), which has recently been extended to incorporate aspects of the new economic geography (Fan, Treyz and Treyz, 2000). Treyz's more recent "new geography" model (2000) is still at an experimental stage and may be difficult to operationalise in the context of integrating its insights with the body of existing European work on structural funds.

Among the single equation econometric evaluations of the impact of the structural funds, some are based on the simple growth regressions, where structural fund investment expenditure indicators are added to the right hand side as an additional explanatory variable in the single-equation model. For example Tondl (1999) uses this type of framework using a panel of regional data. A similar approach is used by Ederveen, *et al*, (2002(b)).

De la Fuente and Vives (1995) examine the impact of the EU Regional Development Fund (ERDF) and of public investment in infrastructure and education on income levels across Spanish regions using a small simultaneous equation model and a decomposition method. They find support to the success of the EU policies in that they boosted regional convergence.

[8] In this section we revert to the older term "Structural Funds". We use this as a familiar, but obviously imprecise, way of referring to the new *Convergence Priority* and *Cohesion Funds*.

Previous evaluation based on fully specified macroeconomic models has also been carried out (Bradley et al.,1995, Roeger, 1996, Bradley, Morgenroth and Untiedt, 2003, and Bradley, Petrakis and Traistaru (eds.), 2004). The main advantage of such model-based evaluations is that they permit one better to evaluate policy impacts compared to the base-line scenarios that assume no policy intervention. Of course the theoretical underpinnings of these models play an important role in determining the size of the impacts. For example in the QUEST model (Roeger, 1996), crowding out mechanisms reduce the overall estimated impact of the structural funds. In the HERMIN model, such crowding out is not incorporated into the model mechanisms, based on two assumptions:

i. The public goods being produced (mainly physical infrastructure and human resources) are complementary to private sector activities, and the economies in question are often operating far below their full capacity.

ii. The EC funding eases the public sector budget constraint, and permits increases public investment with only limited extra tax or debt financing of the required domestic co-financing. This is also likely to reduce the extent of crowding out.

The HERMIN macro-sectoral modelling framework has been widely applied to structural fund analysis at the national level (Greece, Ireland, Portugal, Spain, the Czech Republic, Estonia, Latvia, Poland) and macro-regional level (East Germany, the Italian *Mezzogiorno,* and Northern Ireland). The main advantage is that at the national and macro-regional level, the HERMIN macro-sectoral framework has a track record in modelling the structural funds in isolation as well as in the context of the Single European Market and Monetary Union (ESRI, 1997 and Bradley, 1998). This has permitted a systematic improvement in impact analysis techniques, since this is a complex area of economic research at the frontier of our knowledge of cohesion processes. Modelling in the new member states can be very difficult, in light of the shifting structures of these economies, and the very limited amount of time series data available. In the next sub-section we briefly review the theoretical foundations of the HERMIN modelling approach..

3.2 The Structure and Theoretical Foundations of HERMIN

The basic macro-sectoral methodology appears to be an appropriate approach to developing a framework for the evaluation of the structural funds at a regional or macro-regional level. The HERMIN model drew its inspiration from the earlier trans-EU *HERMES* model and has reasonably firm macro-theoretical foundations and can be operationalised even when data for calibration are limited to a few annual observations.[9]

To be of use for structural fund analysis, there were three requirements which the empirical implementation of the HERMIN model needed to satisfy:

[9] For the "old" member states, annual data time series are usually available at least from the early 1980s, although structural change reduces the utility of the very early data. For the "new" member states of the CEE region, reliable annual national accounting data are usually only available from the mid-1990s, i.e., after the initial years of transition were over. This places obvious constraints on the ability to carry out econometric analysis, and to use that analysis in the construction of macromodels (see Bradley, Petrakis and Traistaru (eds.), 2004).

i. The model must be disaggregated into a small number of crucial sectors in order to permit the identification and treatment of the key sectoral shifts in a developing economy over the years of the structural fund programme.

ii. The model must specify the mechanisms through which the recipient national or regional economy is connected to the external world. The external economy is a very important direct and indirect factor influencing the economic growth and convergence of the smaller recipient countries, through trade of goods and services, inflation transmission, international population migration and commuting (mainly in the case of Ireland and East Germany) and inward foreign direct investment.

iii. The modelling framework must recognise that a possible conflict may exist between actual situation in the less developed recipient countries - as captured in the HERMIN model calibrated with historical data from the recent past - and the new configuration/structure towards which these economies are evolving in the world of EMU and the Single European Market.

Thus the HERMIN model framework focuses on key structural features of lagging economies with respect to such issues as:

a) Economic openness, exposure to external and world trade, and response to external and internal shocks;

b) Relative sizes and characteristics of the traded and non-traded sectors and their development, production technology and structural change;

c) Wage and price determination mechanisms;

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

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

To satisfy these requirements, the HERMIN framework is designed as a macro-econometric model composed of four sectors, namely: manufacturing (a mainly traded sector), market services (a mainly non-traded sector), agriculture and government (or non-market) services. It incorporates the theoretical underpinning of a small open economy model with a Keynesian role for domestic demand[10]. This level of disaggregation is the minimum necessary to identify the key sectoral shifts in a developing (regional) economy over the years of the Structural Fund programme.

The model is made up of three main blocks:

i. A supply-side (determining output, factor inputs, wages, prices, productivity, etc.);

ii. An absorption side (determining the expenditure side of the national accounts such as consumption, stock changes, etc.);

10 Available data do not permit the identification of traded and non-traded sectors precisely. The use of manufacturing and market services serves as a rough approximation.

iii. An income distribution side (determining private and public sector income).

Conventional Keynesian mechanisms are at the core of the HERMIN model in the short run. Thus, the interaction of the expenditure and income distribution sub-components generate the standard multiplier properties of the HERMIN model.[11] However, the model also has neoclassical features, mainly associated with the supply sub-component. Thus, output in manufacturing is not simply driven by demand. It is also influenced by price and cost competitiveness, where firms seek out minimum cost locations for production (Bradley and Fitz Gerald, 1988). In addition, factor demands in manufacturing and market services are derived using a CES production function, where the capital/labour ratio is sensitive to relative factor prices. The incorporation of a structural Phillips curve mechanism (through which the wage bargain can be sensitive to tension in the labour market – as measured by unemployment) introduces further relative price effects. Although, it should be noted that it is very difficult to calibrate the Philips curve mechanism in the new member states, since their labour market institutions are still in a process of evolution.

The schematic structure of the HERMIN model is illustrated in Figure 3.1. The national accounts define three ways of measuring GDP: the output basis, the expenditure basis and the income basis. On the output basis, HERMIN disaggregates this into four sectors: manufacturing (OT), market services (ON), agriculture (OA) and the public (or non-market) sector (OG). On the expenditure side, HERMIN disaggregates into five components: private consumption (CONS), public consumption (G), investment (I), stock changes (DS), and the net trade balance (NTS). 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.[12] The output-income identity is used to determine corporate profits residually. Finally, the equations in the model can be classified as either behavioural or identities. 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 that have important consequences for the behaviour of the model as well.

Apart from capturing the usual macroeconomic relationships, an important aspect of regional modelling is that it needs to take account of spillovers, linkages and leakages which are less important at the national level but which can have a substantial impact at the regional level. This is particularly important for structural fund analysis since such investments are likely to generate large-scale inter-regional demand and supply spillovers.

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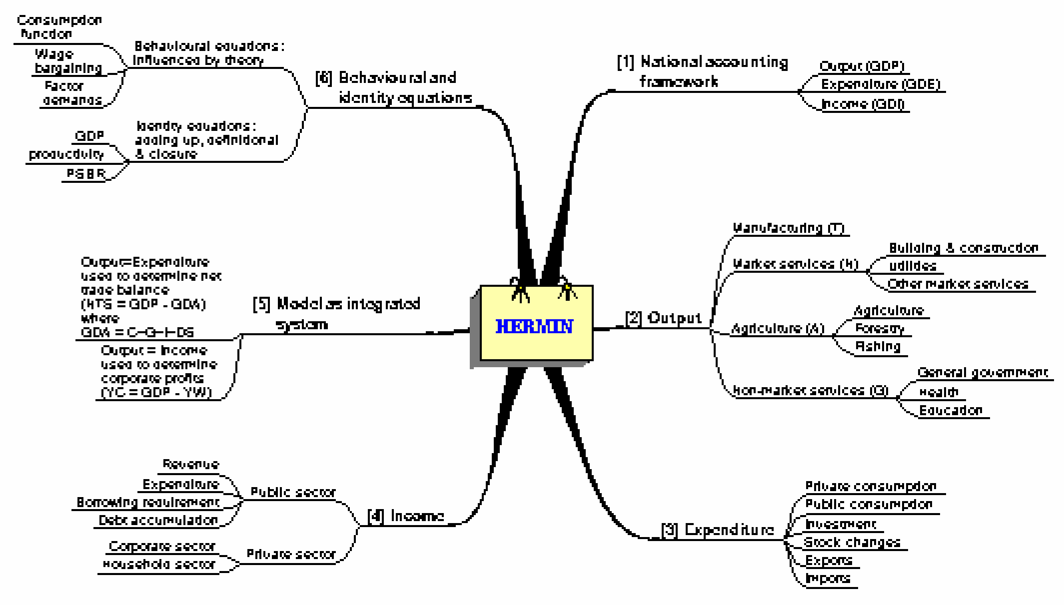
11 Expectations in the HERMIN model are assumed to be autoregressive (i.e., static or backward-looking). It should be noted that the Commissions own QUEST model contains forward-looking (or model consistent) expectation mechanisms. These result in policy "crowding out" and much smaller multipliers. But since the bulk of Structural Fund expenditures are mainly on public goods (e.g., physical infrastructure and education/training), it might be questioned if "crowding out" is fully relevant. In circumstances where crowding out is relevant, e.g. fiscal policy, the HERMIN model can be easily adapted to model consistent expectations (see Bradley and Whelan, 1997).

12 Note that HERMIN, being a traded/non-traded model, does not contain separate export and import equations, but only a net trade surplus (NTS). This has implications for the trade analysis to be presented in Section 6 of this report.

For example, an investment may have an impact on the labour market by generating additional employment. Of course, individuals may commute across regional boundaries or may even migrate in order to find employment. Thus, an investment may impact on the labour force by inducing migration and commuting. These type of labour market impacts have been incorporated into some of the existing macro models (e.g., the East German model: see Bradley, Morgenroth and Untiedt, 2003).

Figure 3.1: Schematic outline of the HERMIN modelling approach



The model functions as an integrated system of equations, with interrelationships between all their sub-components. The essential core of the model consists of a smaller number of equations, of which only about 20 are fully behavioural in the economic sense.[13] The models are calibrated using time series of national accounts data from the period 1980-2002 (for the "old" member states, and from 1994-2002 for the new member states (see Bradley, Petrakis and Traistaru (eds.), 2004, for references).. The HERMIN model databanks are usually developed in Excel and TSP format, and model calibration is carried out using TSP. The models are constructed and simulated using the WINSOLVE software package.

3.3 The availability of HERMIN models

Since the early 1990s, the HERMIN macro-modelling framework has been developed specifically for the evaluation of structural fund impacts. Initially the model was applied to Ireland and the other three original "cohesion" countries (Greece, Portugal and Spain), as documented in a special issue of *Economic Modelling* (see Bradley, Whelan and Wright, 1995). The HERMIN modelling framework was extended to the economies of the then

[13] There is a distinction in HERMIN between a "fully" behavioural equation (like the consumption function) and a "technical" equation (like a tax revenue equation). In the first, the variables in the equation are linked by means of a theoretical framework (e.g., the permanent income hypothesis). In the second, the variables are linked by means of an identity or a quasi-identity.

candidate countries of Central and Eastern Europe from the mid-1990s. In the late 1990s, the HERMIN model was applied to East Germany (in a regionalized form), and in 2003 it was applied to the Italian *Mezzogiorno* (see ESRI/CRENoS, 2004(a)). The most recent application has been to the East German land of Sachsen-Anhalt (GEFRA, 2004).

In terms of the present project's requirement for country and regional coverage, the following is the current situation with respect to the availability of HERMIN models:

(a) Current member states/regions (with operational HERMIN models):

Greece: Updated (to 2001) version available, last used on the *ex-post* evaluation of CSF 1994-99 and *ex-ante* evaluation of CSF 2000-2006.

Portugal: Updated (to 2001) version available, last used on the *ex-post* evaluation of CSF 1994-99 and *ex-ante* evaluation of CSF 2000-2006.

Spain: Updated (to 2001) version available, last used on the *ex-post* evaluation of CSF 1994-99 and *ex-ante* evaluation of CSF 2000-2006.

East Germany: Version calibrated using data up to 1998 (due to restructuring of German regional accounts), and last used on the *ex-post* evaluation of CSF 1994-99 and *ex-ante* evaluation of CSF 2000-2006. More recently, the East German HERMIN model has been completely updated, making use of the new formulation of the German national and regional accounts for the period to 2002 (GEFRA, 2004).

Italian *Mezzogiorno*: Updated (to 2001) version available, last used on the *ex-post* evaluation of CSF 1994-99 and *ex-ante* and *mid-term* evaluation of CSF 2000-2006 (ESRI/CRENoS, 2004(b)).

(b) New Member States and candidate countries (with operational HERMIN models):

Estonia: Updated (to 2002) version available, last used on the *ex-ante* evaluation of NDP 2004-2006 and for the preparation of medium-term forecasts.

Latvia: Older (to 1999) version available, last used on the *ex-ante* evaluation of pre-accession NDP and for the preparation of medium-term forecasts. Updated recently using the latest national accounts for 2001.

Poland: Updated (to 2002, and the revised ESA 95 National Accounts) version available, last used on the *ex-ante* evaluation of NDP 2004-2006 and for the preparation of medium-term forecasts.

Hungary: New HERMIN model developed (to 2001) and available for use for impact analysis of cohesion policy reform.

The Czech Republic: Older (to 2000) version available, last used on the *ex-ante* evaluation of NDP 2004-2006 and for analysis of a series of policy issues.[14]

14 Barry, F., J. Bradley, M. Kejak and D. Vavra (2003). "The Czech economic transition: exploring options using a macrosectoral model", Economics of Transition.

Slovenia: First developed in 1997-98, and recently completely revised and updated using the latest National Accounts to 2002.

Romania: First developed in 1997-98, and has been recently updated. Unfortunately a complete set of model data could only be constructed for the period up to 1999.

(c) New member and candidate countries that do not have HERMIN models:

i. Lithuania
ii. The Slovak Republic
iii. Bulgaria
iv. Cyprus
v. Malta

In light of the short time scale of the contract (two months), it would have been impossible to develop HERMIN models *de novo* for Lithuania, the Slovak Republic, Bulgaria, Cyprus or Malta. It is proposed to handle these countries as follows:

(1) Lithuania: The results for Estonia and Latvia can be used to infer the likely consequences for Lithuania, since the three Baltic States have a certain similarity in structure and performance.

(2) The Slovak Republic: The results for the Czech Republic might be used to infer the likely consequences for the Slovak Republic, since the two countries have a certain degree of similarity in their level of development, location and cultural heritage.

(3) Bulgaria: The results for Romania can be used to infer the likely consequences for Bulgaria, since the two countries have a certain similarity in their level of development, location and cultural heritage. However, as will be discussed later in Section 6, the analysis carried out using the Romanian model suggests a degree of instability that calls into question the utility of the results.

(4) Cyprus and Malta: It is not proposed to carry out a HERMIN-based analysis of these two island states. A simple modelling approach could be developed, using published data, but this would fall short of the coverage of a typical four-sector HERMIN model.

[4] How the impact of structural funds is modelled in HERMIN[15]

4.1 Introduction

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

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

2) If the unit of analysis is a country or a single macro-region of a country, there is no requirement to distinguish, say, the impact of a new road in one sub-region as compared with another sub-region.[16]

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

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

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

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

a) EU transfers in the form of subventions to domestic public authorities;
b) Domestic public sector co-financing as set out in the structural fund treaties;[17]
c) Domestic private sector co-financing as set out in the structural fund treaties.

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

15 Once again, for simplicity, in this section we use the term “Structural Funds” to embrace the new concepts of *Convergence Priority* and *Cohesion Funds*.
16 Of course, in the design of a Structural Fund programme, a sub-regional breakdown is an essential part of comparing the benefits of alternative investment strategies.
17 Note that “domestic” public sector co-finance in the case of East Germany and the Italian *Mezzogiorno* includes a large intra-German transfer from West to East, and a similar transfer from Northern Italy to the southern *Mezzogiorno* region.

Structural fund actions influence economies through a mixture of supply and demand channels. Short-term demand (or Keynesian) effects arise as a consequence of increases in the expenditure and income policy instruments associated with structural fund policy initiatives. Through the "multiplier" effects contained in the models, there will be knock-on increases in all the components of domestic expenditure (e.g., total investment, private consumption, the net trade surplus, etc.) and the components of domestic output and income. These demand effects are of transitory importance and are not the core *raison d'etre* of the structural funds, but merely a side-effect. Rather, the structural fund interventions are intended to influence the long-run supply potential of the economy. These so-called "supply-side" effects arise through policies designed to:

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

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

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

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

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

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

The second type of externality arises through the increased total or embodied factor productivity likely to be associated with improved infrastructure or a higher level of human capital associated with training and education. This is referred to as a factor productivity externality. A side effect of increased factor productivity is that, in the artificially restricted context of a fixed level of output, labour must be shed.[18] The prospect of such "jobless growth" is particularly serious in economies where the recorded rate of unemployment as well as the rate of hidden unemployment is already high. Thus, the factor productivity externality is a "two edged" process: industry and market services become more productive and competitive, but labour demand is weakened if output growth also remains weak. However, if factor productivity is driven up, real incomes will rise, and these effects will cause knock-on multiplier and other benefits throughout the economy. Hence, the role of the output externality is more unambiguously beneficial than the factor productivity elasticity. But in both cases, these externality effects promote faster transitional growth to a higher income plateau.

The elasticities relating the beneficial externality effects to the structural fund investments, particularly in relation to infrastructure, have been chosen on the basis of an exhaustive literature review (see Appendix to this section for details). The empirical literature suggests that the values for the elasticity of output with respect to increases in infrastructure are likely to be in the region between 5 and 40 per cent, with small regions at the lower end of the scale. With respect to human capital, elasticities in the same range also appear reasonable.

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

4.2 Linking the externality mechanisms into the HERMIN model

4.2.1 Direct output externalities

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

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

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

One simple way of describing this process is to link the growth of infrastructure and the increases in human capital to a modified version of the HERMIN behavioural equation that is used to determine manufacturing sector output (OT). The original equation determining OT is of the form:

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

where OW represents external (or world) demand, FDOT represents the influence of domestic absorption, ULCT/POT represents real unit labour costs, POT/PWORLD represents cost competitiveness, and t is a time trend (picking up all other systematic factors, such as sectoral restructuring). To take account of output externalities associated with infrastructure and human capital, the following two terms are added to the right-hand side of the above equation:

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

where output in the manufacturing sector (*OT*) is now directly influenced by any increase in the stock of infrastructure and human capital (KGINF and NTRAIN, respectively) over and above a baseline value for these stocks ($KGINF_0$ and $NTRAIN_0$, respectively).[19] For the present we ignore any interactions and complementarities that may exist between physical infrastructure and human capital, since so little is yet known about this aspect of the CSF.[20]

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

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[19] Thus, if the stock of infrastructure increases by 1 per cent relative to the baseline stock, output in manufacturing (OT) is boosted directly by η_1 per cent. If the stock of human capital increases by 1 per cent relative to the baseline stock, output in manufacturing (OT) is boosted directly by η_2 per cent

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

4.2.2 Indirect factor productivity externalities

The first type of externality mechanism, treated above, boosts output directly. The second type of mechanism works indirectly through improving factor productivity. Factor productivity externalities can be associated with improved supply conditions in the economy, brought about as a result of investment in human capital and public infrastructure. These are incorporated into HERMIN by modifying the production technology in manufacturing and market services. This technology is modelled in HERMIN by means of the CES (or Constant Elasticity of Substitution) production function.[21] A simple way of doing this is to endogenise the "scale" parameter in the CES production function, 'A', which is now modelled as a function of the stock of public and human capital. Increases in the value of 'A' imply that for a given amount of inputs a higher level of output is produced.

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

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

where A is the scale parameter, which can be considered to represent the state of technology, and L and I are the labour and investment inputs, respectively. Public infrastructural investment are likely to increase the efficiency of the market services sector by cutting down on the costs of producing transport and other communication services, and by opening up greater opportunities for domestic competition to take place in the provision of non-traded goods. Such cost reductions will have a favourable supply-side effect on the internationally exposed manufacturing sector.

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

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

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

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

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

badly designed and poorly executed, the relationship between training and increased human capital will be tenuous.[22]

Suppose we assume that, prior to the implementation of the CSF, the number of labour force participants trained to a specified level, $NTRAIN_0$, is known. If the ESF element of the CSF is used to train an additional number of people, giving a total of $NTRAIN_t$ trained labour force participants in year t, then the scale parameter in the production function can be modified as follows:

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

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

4.3 Handling CSF physical infrastructure impact analysis

The HERMIN model assumes that any CSF-based expenditure on physical infrastructure that is directly financed by EU aid subvention (IGVCSFEC) is matched by a domestically financed public expenditure (IGVCSFDP).[23] Hence, the total public CSF infrastructural expenditure (IGVCSF) is defined in the model as follows (in current prices):

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

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

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

where δ is the assumed rate of capital stock depreciation (e.g., 2 per cent per year).[24] This accumulated stock is divided by the (exogenous) baseline non-CSF stock ($KGINF_0$) to give the CSF-related relative improvement in the stock of infrastructure (KGINFR):

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

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

As regards the public finance implications of the CSF, the total cost of the increased public expenditure on infrastructure (IGVCSF) is added to the domestic public sector capital

[22] The macro output effects of a poorly designed training scheme, whose implementation was measured in terms of inputs, would show up in the form of very low externality elasticities. In other words, the macro benefits would be merely the short-run Keynesian income-expenditure ones.
[23] We ignore all private sector co-finance (see previous discussion).
[24] Public infrastructure is usually assumed to have a lower rate of depreciation than private capital stock. Typically, a 2 per cent rate is assumed for public infrastructure, and rates in the region of 5 per cent for private capital.

expenditure (GK). Any increase in the domestic public sector deficit (GBOR) is limited by the extent of EU CSF-related aid subventions (IGVCSFEC). Whether or not the post-CSF public sector deficit rises or falls relative to the no-CSF baseline will depend both on the magnitude of domestic co-financing and the stimulus imparted to the economy by the NDP shock. This differs from country to country as well as from programme to programme.

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

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

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

where η is the externality elasticity. The way in which the externality elasticity can be approximately calibrated numerically, drawing on the empirical growth theory research literature, was discussed above (see appendix to this section for details). In any model-based simulations, the externality effects can be phased in linearly over an extended period, reflecting the implementation stages of the CSF programmes and the fact that benefits from improved infrastructure may only be exploited with a lag by the private sector in terms of increased activity.

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

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

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

The first type of externality is an unqualified benefit to the economy, and directly enhances its performance in terms of increased manufacturing output for given factor inputs. However, the second type is likely to have a negative down-side, since labour will be shed as total factor productivity improves, unless output can be increased sufficiently to offset this loss. Inevitably production will become less labour intensive in a process that has only limited analogues in the more developed and technologically advanced economies in the EU core.[25]

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

4.4 Handling CSF human resources impact analysis

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

$$GTRSF = GTRSFEC + GTRSFDP$$

As regards the public finance implications for each of the Objective 1 countries, the total cost of the increased expenditure on human resources (GTRSFEC+GTRSFDP) becomes a part of the broader category of public expenditure on income transfers (GTR). However, the increase in the domestic public regional deficit (GBOR) is limited by the extent of CSF aid subventions by the EC (GTRSFEC).

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

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

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

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

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

Hence, total CSF 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.[26] This formula is inverted in the HERMIN model and used to estimate the approximate number of extra trainees that can be funded by the CSF for a given total expenditure GTRSF on human resources, i.e.,

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

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

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

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

The number of CSF-funded trainees (measured in trainee-years) is accumulated into a 'stock' (KSFTRAIN) by means of a perpetual inventory-like formula, with a 'depreciation' rate β:[27]

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

In order to quantify the increase in the stock of human capital (measured in trainee years), we need to define the initial pre-CSF stock of human capital, $KTRAIN_0$. This is a conceptually difficult challenge, and we are again forced to simplify drastically.[28] 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 CSF. 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[29]

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 CSF 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 CSF human resources programmes:

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[27] Human capital (measured by accumulated years training) can "depreciate" in the sense that people may leave the labour force, and as time passes, the usefulness of the previous training is diminished.

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

[29] 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 CSF human resource programmes. These effects are limited in magnitude, particularly in countries where the income multipliers are small (e.g., small open economies). In addition, a sizeable fraction of the CSF payments to trainees may simply replace existing unemployment transfers. The 'overhead' element of these programmes (equal to OVERHD*SFWAG) is assumed to boost non-wage public consumption and investment directly.

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

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

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

Two types of externality effects associated with human capital are introduced into the HERMIN model:[30]

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

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

[30] It is well known that untrained and/or unskilled workers compete in the labour market in a very ineffective way, and are much more likely to end up as long-term unemployed than are skilled/trained workers (Layard, Nickell and Jackman, 1991). We assume that all ESF trainees are in the unskilled or semi-skilled category, and that their temporary removal from the labour force for the duration of their training scheme has almost no effect on wage bargaining behaviour through the Phillips curve 'pressure' effect in the HERMIN wage equation. This assumption is consistent with the stylised facts of the hysteresis in Irish and Portuguese labour markets (Bradley, Whelan and Wright, 1993; Modesto and das Neves, 1993), and is implemented in the HERMIN model by defining a 'corrected' measure (URP) of the unemployment rate (UR) for use in the Phillips curve.

4.5 Handling direct aid to the productive sectors

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

These expenditures cover a very wide rage of activities. For example, in the Irish CSF 1994-2000, they covered programmes in indigenous industry (company development, inter-company linkages, business innovation centres,), inward investment (investment grants), research and development, marketing, tourism, etc.[31] These programmes undoubtedly benefit the recipient countries. But given their heterogeneous nature, it is very difficult to summarise their likely impacts in the way that we can do for physical infrastructure and human resources.

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

[31] For a more detailed account of the coverage of direct aid to the Irish productive sectors, see Honohan, (ed.), 1997.

Appendix S4 Economic impacts of infrastructure and human capital

A4.1 The role of infrastructure

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

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

The discussion so far has focused on the ways in which infrastructure impact on the economy. However, a closely related is the issue of optimal level of infrastructure. As was outlined above, a number of theoretical models make predictions about the optimal level, but empirically this is often ignored. Here the observation of Fernald (1999) is relevant. He notes, “intuitively the interstate [road] system is highly productive, but a second one would not be”. In other words building roads in excess of a particular optimal level would of course not raise productivity. Indeed, it is well known in transport studies that the final section of road that completes a network has the highest return. This might explain the sensitivity of the output elasticity of infrastructure in the conventional linear models to the sample size. As some researchers have found for the US as one increases the sample size to include more recent years, the estimated output elasticity declines, indicating a lower marginal product and return.

This issue has recently been addressed by Duggal, Saltzmann and Klein (1999) who specify a model where the growth rate of technical change is non-linearly determined by infrastructure, which allows the production function to take an S-shaped form, where the return to infrastructure is initially low and then increases until it reduces again at higher levels of infrastructure. Their empirical results confirm that the impact of infrastructure is not constant and declines as the level of infrastructure approaches the optimal level.

Further evidence is provided by Bougheas, Demetridaes and Mamuneas (2000), who estimate growth regressions, including the level of infrastructure and squared infrastructure. Given their results it is possible to calculate the contribution of infrastructure to growth for all of the countries in their sample. They find that in some cases such as Belgium, the density of roads is so large that it actually decreases growth, while countries such as Austria have about the optimal level of infrastructure for growth. However, they also find that the stock of roads in all the Cohesion Countries is below the optimal stock[32].

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

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

In our simulations we use elasticities for the impact of infrastructure that are drawn from the now very sizeable international literature. While there are many studies on the cohesion countries, and especially Spain, which confirm the significant positive impact of infrastructure (see the table below for a summary of the results), lack of data has prevented credible estimates from becoming available for the new member states. Consequently we have to pick elasticities without having a body of direct results to inform our choice. However, given the discussion above along with some basic knowledge of the state of infrastructure in the new member states, it is extremely likely that both the quality and quantity of infrastructure is below the optimal level in these countries[33] (European Commission, 2004).

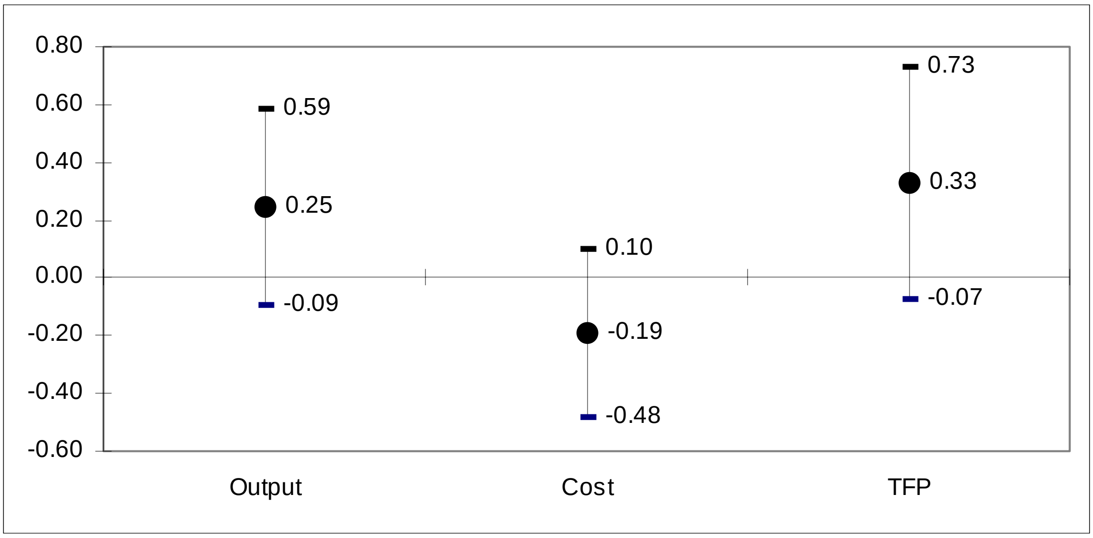
The results of the literature, which are summarised in Figure A4.1 below show that the output and total factor productivity (TFP) elasticities are positive indicating that an increase in

[32] This is particularly apparent if one considers quality differences.
[33] West Germany appears to be at about the optimal level according to Bougheas, Demetriades and Mamuneas, 2000.

infrastructure increases output and productivity. Similarly, the cost elasticities are negative suggesting that an increase in infrastructure reduce costs. Eliminating the extreme results of Denny and Guimoard (1997) and Dalmagas (1995)[34], which are not plausible, the average output elasticity is 0.25, that for TFP is 0.33 and the cost is –0.19[35]. Similarly, Figure A4.1 shows the average Cost and TFP elasticities, and their two standard error bounds. In all cases a lower bound of zero appears reasonable as it is unlikely that a one percent reduction of the existing capital stock would increase output, while it is reasonable in the case of a country or region possessing the optimal stock that a one percent increase in infrastructure will have no impact. Thus, the elasticities which we use, namely output elasticities of 0, 0.2 and 0.4 and productivity elasticities of , 0, 0.1 and 0.2 are within the range of those found in the literature.

It is important to note that these elasticities are estimated for the actual stock of capital that is in place, that is, they refer to the average productivity of that stock. Thus, they take account of the fact that some of the capital may not be very productive, either because the facility has been build in the wrong place (for example, a motorway in a remote unpopulated area) or the wrong type of facility has been built (for example, a second presidential palace). Thus by using these elasticities, we also assume that the effectiveness of the facilities that are built using Structural Funds, is similar to that which is already in place.

Figure A4.1. Average elasticities and confidence intervals



[34] The results of Denny and Guimard imply a return in excess of 100% in the first year. Similarly the results of Dalmagas imply a excessive return when taking the cost and profit elasticities, while the output elasticity implies that a reduction of infrastructure would increase output significantly.
[35] For studies for which a range of elasticities is quoted, the average of the two is taken in this calculations.

Table A4.1: Results of empirical studies on the impact of infrastructure

Country	Authors	Publication Year	Period	Type	Elasticity
Spain	Bajo-Rubio and Sosvilla-Riveroet	1993	National 1964 - 1988	Output	0.16 to 0.19
Spain	Pereira and Roca-Sagales	2001	National 1970-1993	Output	–0.39 to1.23 0.52 all sectors
Spain	Canalata, Arzoz and Garate	1998		Output	0.03 to 0.15
Spain	Cutanda and Paricio	1994	Regional	Output	0.37 to 0.62
Spain	De la Fuente and Vives	1995	Regional	Output	0.21
Spain	Flores de Frutos et.al.	1998	National 1964-1992	Output	0.21
Spain	Mas et.al.	1996	Regional, 1964-1991	Output	0.07 to 0.08.
Spain	Mas et.al.	1998	Regional, 1964-1993	TFP	0.11
Spain	Moreno, et.al.	2002	12 Sectors, 15 Regions 1980-1991	Cost	-0.02
Greece	Mamatzakis	1999	Industries 1959-1990	Cost	-0.02 to -0.78
Greece	Mamatzakis	2002	National 1959 - 1994	Output	0.14
Greece	Rovolis and Spence	1999	Regional, 1982 - 1991	Output	0.25 to 0.74
Greece	Rovolis and Spence	2002	Regional, 1982-1991	Cost	-0.058 to –0.071
Greece	Dalmagas	1995	National, 1950-1992	Output Cost Profit	-1.24 -2.35 1.06
Ireland	Kavanagh	1997	National, 1958-1990	Output	0.14 (not significant)
Ireland	Denny and Guiomard	1997	National, 1951-1994	Output	0.93 to 6.3
Ireland	Morgenroth	2003	National, Sectors 1960-2000	Output	0.06 to 0.28
Italy	Bonaglia and La Ferrara	2000	Regional 1970-1994	Output TFP Cost	0.05 to 0.50 0.47 -0.03 to –0.2 (mixed results for disaggregated data)
Italy	Picci	1999	Regional, 1970-1995	Output	0.07 to 0.5
Italy	La Ferrara and Marcellino	2000	Regional 1970-1994	Output TFP Cost	0.17 to 0.56 0.24 to 0.82 0.27
Italy	Destefanis, and Sena	2002	Regional 1970-1995	TFP	0.15 to 1.06
Italy	Destefanis, and Sena	2003	Italian Regions 1970-1995	TFP	-0.06 to 0.49 for core infrastructure
Portugal	Lighthart	2000	National, 1965-1995	Output Cost	0.1 to 0.7 -0.05 to –0.2

A4.2 The role of human capital

The role of human capital is a vital field of research since human capital can be viewed as an essential prerequisite to the adoption of the types of change induced by globalisation and new technologies. Human capital has also been incorporated into endogenous growth models in order to explain sustained long-run growth (see Lucas, 1988). Again, human capital enhances the productivity of all private factors. A number of issues and challenges emerge from the literature and will be reviewed[36].

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

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

In contrast to the empirical macro literature, there is a broad consensus in the empirical micro economic literature that education has a positive and significant effect on individual earnings (see Ashenfelter, Harmon & Oosterbeek, 1999). This further highlights the challenge to reconcile and integrate the micro- and macroeconomic approaches. Thus, theoretical and empirical investigations into the economy-wide impact of human capital on aggregate output and growth still continue and no firm consensus has yet emerged.

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

[36] These are reviewed in more detail in Sianesi and van Reenen (2003).

settle this debate and we therefore simply review some of the interesting results which have been obtained.

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

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

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

Our brief review of the academic literature indicates that, on balance, human capital is likely to have a positive impact on output and that the output elasticity probably lies in the range of 0.15 to 0.4. However there is obviously an urgent need for further work in this area. In particular the existing literature has yet to address the issue of spillovers of human capital as there have been few attempts to estimate the productivity effect of the presence of a highly educated worker on a worker with lower human capital (a notable exception is Acemoglu and Angrist, 2000). Furthermore, one may consider the interaction between infrastructure and human capital. In this regard it is possible that human capital develops more slowly in countries with poor infrastructure (after all universities and schools are a form of infrastructure). Furthermore the effectiveness of human capital may be lower where agents are constrained by poor infrastructure. However, these links have yet to be investigated in the literature.

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[5] Convergence and cohesion impacts : 2007-2013

5.1 Introduction

In the previous three sections we have described the nature of the *CP* and *CF* financing, the main properties of the HERMIN model, and how Structural Fund-type policy initiatives can be incorporated into the HERMIN model. In this section we proceed to carry out policy simulations. This will involve two main steps.

The first step requires us to set up a baseline scenario for all the countries that are modelled using HERMIN. In theory, the assumptions used in this baseline should be identical to the subsequent "with-*CP/CF"* simulation, with one exception. Namely, the *CP/CF* expenditure is set at zero in the baseline. For the "old" EU member states, a second baseline assumption could be the continuation of previous level of *CP/CF* aid.

The second step in this kind of simulation exercise requires the execution of the *CP/CF* policy scenarios, based on the funding guidelines provided by the Commission, using the available country and regional HERMIN models. For those countries not modelled using HERMIN, i.e., Lithuania, the Slovak Republic, Cyprus, Malta and Bulgaria, one can attempt to use the HERMIN results from the second step to infer likely impacts on these countries based on those close-country analogues for which we have models.

The terms of reference of the project called for the use of the alternative baseline assumption for the "old" EU member states: Greece, Portugal, Spain, and for the two macro regions, East Germany and the Italian *Mezzogiorno*. This alternative assumption involved the continuation of previous (2000-2006) level of *CP/CF* aid, prior to simulating the new 2007-2013 *CP/CF* programme. However, when we examined how this alternative assumption might be implemented in practice, serious difficulties arose. For example, there were no data that could be used to provide likely actual levels of CSF 2000-2006 expenditure for the terminal year 2006. In fact, the data availability from the mid-term evaluation of CSF 2000-2006 was sketchy at best, and often so incomplete as to be unusable in HERMIN simulations. In addition, it was unclear how one might index the CSF 2000-2006 data from the CSF financial tables, prepared in late 1999, in order to arrive at a suitable "real" expenditure in the year 2006. A further complication was that the later programme is obviously a continuation of the earlier (2000-2006) one. So, by the year 2006, the supply-side beneficial impacts of the earlier programme would have to be taken into account in the analysis.

In the light of these conceptual difficulties, we decided to abandon the use of the alternative baseline for the "old" member states and macro regions. However, to the extent that a satisfactory set of CSF 2000-2006 data can be derived for the terminal year 2006, in real 2006 prices, there are three simple possible outcomes:

i. If the real 2006 expenditure at the end of CSF 2000-2006 is greater than the real expenditure for 2007-2013, then the implementation of *CP/CF* 2007-2013 will cause a reduction in the net stimulation of the economy relative to the impact of CSF 2000-2006.

ii. If, on the other hand, it turns out that the real 2006 expenditure at the end of CSF 2000-2006 is less than the real expenditure for 2007-2013, then the impact of *CP/CF* 2007-2013 will be to stimulate the economy by more than the impact of CSF 2000-2006.

iii. In the unlikely event that the *CP/CF* programmes for 2007-2013 are identical in real terms to the 2006 expenditures at the terminal year of CSF 2000-2006, then there will be no net increase or decrease in the short term, but of course there will be continual beneficial supply-side impacts in the longer term.

So, the situation concerning the second "old" member state baseline is complicated. Towards the end of CSF 2000-2006, many projects infrastructural and human resource projects will be completed, or nearing completion. Consequently, the positive externalities will be generating increased output and productivity, even after the CSF 2000-2006 programmes cease at the end of the year 2006.[37] This is one aspect of the problems created by assuming that the different CSF or *CP/CF* programmes are discrete and unrelated to each other, when it is clear that the subsequent programmes are simply continuations of the earlier policies, and an entire run of CSF programmes should logically be examined as a continuous policy unit.

In the remainder of this section, we will only examine the "zero funding" baseline. As pointed out in the previous paragraph, even this is not an ideal assumption, but at least it has the virtue of simplicity. In the simulations to be reported in the remainder of this section we make a series of standard assumptions, and apply them to all the models. In the next section (Section 6) we will relax some of these assumptions and vary the assumptions. For example, for each country and regional HERMIN model, we will carry out a sensitivity analysis with respect to the magnitudes of the model "spill-over" mechanisms (the so-called "externality elasticities"), as well as discussing the consequences of different funding allocation as between the main types of investments (physical infrastructure, human resources and aid to productive sectors).

5.2 Background to the policy analysis simulations

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

i. For all the models, we carry out baseline model simulations, starting in the year of the most recent historical data that is available. This will vary from model to model, and ranges between the year 1999 (Romania) to the year 2002 (Estonia, Poland). We continue the model simulation to the year 2020, i.e., seven years after the termination of the 2007-2013 programme. A series of "stylised" assumptions are made for all the international variables as well as for all the domestic policy variables. Some effort is made to produce GDP growth projections that are broadly in line with the "stylised" projections provided by DG-ECFIN, and referred to in section 2 above.

ii. For all available models (i.e., for the five main beneficiaries from the "old" EU, as well for six of the ten new member countries and for one of the two candidate countries), the baseline is taken as being representative of the case of no *CP/CF* funds. It must be stressed that the "no *CP/CF*" case is very artificial, since in the absence of any EU-supported programme, there almost certainly would be a substitute domestically funded public investment programme, albeit smaller in magnitude.[38]

[37] We assume, for simplicity, that CSF 2000-2006 will cease at the end of the year 2006, and ignore the "n+2" issue.
[38] It might be held that, in the absence of such large-scale public policy shocks, the underlying structure of the economies would have changed and that the use of HERMIN models calibrated with

iii. We then set the *CP/CF* funds at their anticipated values (as given in Section 2), and re-simulate all the available models. Since the programmes do not start until the year 2007, clearly the simulation path from 1999 to 2006 will be identical to the case of "no-*CP/CF*" simulation described above.

iv. For all available models, the "no-*CP/CF*" simulation results are subtracted from the "with-*CP/CF*" simulation results, and this is used as a measure of the contribution of the *CP/CF*.

Concerning the baseline simulation. in Section 2 we described the DG-ECFIN forecasts for the recipient countries (Figure 2.1). Ideally, we should try to reproduce these forecasts in the HERMIN baseline simulations, in particular since the *CP/CF* funding allocations were derived from the GDP levels contained in the DG-ECFIN forecasts. But we probably should not do so. For example, it is not clear if the DG-ECFIN forecasters have taken account of the likely impact of *CP/CF* funding in their post 2006 forecasts. But even if we were able to reproduce these forecasts for the five current main beneficiaries, how would one interpret the "CSF 2000-06 continuation" baseline? In fact, we carry out independent projections, based on very simple forecasts of the external environment and the domestic policy environments. Our forecasts for the post historical sample period are broadly similar to the DG-ECFIN ones, but usually with somewhat lower growth rates.[39]

A second point concerns the set of "standardised" policy choices made in the with *CP/CF* simulations. These mainly involve the externality elasticities, which are key influences on the longer term supply-side impacts of higher levels of the stock of physical infrastructure and of human capital.. Identical *CP/CF* mechanisms as well as identical elasticities for all models are assumed in this section. Consequently, the simulation outturns can only differ because the underlying HERMIN models for the different countries have different properties. This will arise fairly naturally through the different sectoral structures in the economies being studied, the differing degrees of openness, the different calibrated parameter values in the HERMIN behavioural equations, etc.

So, the simulations in this section only give a partial answer to the question: "what are the impacts of the *CP/CF* programmes on the recipient economy?". If the *CP/CF* programmes were to be implemented in each country or region in such a way that they were equally effective (in the sense of generating similar externality spillovers for each percentage rise in the stock of physical infrastructure and of human capital), then the simulations that we describe in this section will provide some guidance to answering the question. But this is unlikely to be the case, and some countries are likely to be better at designing effective investment programmes than others. However, *ex ante* we have only the most qualitative sense of how efficient individual National Development Plans are likely to be. This will be a

historical CSF-inclusive data is invalid (the so-called "Lucas critique" of the use of econometric models to analyse policy impacts). However, the HERMIN models contain explicit sub-models of the structural changes that are associated with the operation of the CSF, so the validity of the Lucas critique is weakened.

[39] Since we are only interested in the difference between the "with" and "without" *CP/CF* simulations, the actual level of the economy is not a vital concern (as it is in the DG-ECFIN forecasts), particularly since the HERMIN models are quasi-linear with respect to shocks. In other words, in HERMIN the impact of a policy shock is relatively invariant to the level of the economy, within broad limits. However, the *CP/CF* funding allocations depend on the DG-ECFIN baseline forecast.

matter for mid-term, or more likely, *ex post* evaluation. We return to this point in the next section, when we examine sensitivity analysis.

We note again that a standard set of "average" externality elasticities were used in all the simulations reported in this section. What this means is the following:

i. In the case of "output" externalities, a value of 20 per cent was selected, as being broadly in the mid-range of the international estimates (see appendix to section 4). Hence, an increase in either the stock of physical infrastructure or of human capital of 1 per cent will directly increase manufacturing output by 0.2 per cent. There are no direct impacts on other sectoral outputs (market services, agriculture and government). But there will obviously be indirect knock-on demand-side impacts on market services.

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

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

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

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

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

5.3 The simulation results

The simulation results are presented in a series of tables listed in the appendix to this section. The countries are presented in alphabetical order, and a standard reporting format is used for each country. The variable short-hand notation is shown on the first page of the appendix to this section. A feature of the HERMIN model is that an effort was made to adopt a standard notation for most of the variables, thus facilitating inter-country comparisons.[40]

Clearly there is a huge amount of information contained in these tables. To illustrate how the results can be interpreted and used, we work through the first case, the Czech Republic.

5.3.1 A detailed example – the Czech Republic

In Table HC4M in the appendix to this section, the first two variables (**GDPM(g)** and **L(g)**) show the annual growth rate of GDP and growth rate of total employment in the baseline (no-

[40] The standardised notation is based on English language economic nomenclature (e.g., GDP, CONS, I, etc.). This also facilitated the learning process for CEE modelling teams, who were able to use and adapt "old" EU member state HERMIN research (Greece, Ireland, Portugal) for their purposes.

CSF) simulation. Technically, these should be close to the DG-ECFIN forecasts, but they tend to be somewhat lower.

The next two variables and show the EC finance (**GECSFRAE(l)**), as well as the "EC plus domestic co-finance" (**GECSFRAP(l)**), both of which are expressed as a percentage of GDP. It should be noted that the values of GECSFRAE (the EC part) are not always identical to the rates implicit in the DG Regional Policy calculations that were used to derive the financial data in the first place. This is because the HERMIN-generated baseline projections are not identical to the DG-ECFIN projections.

The next two variables give an indication of the percentage increase in the stocks of physical infrastructure (**KGINFR**) and human capital (**KTRNR**) caused by the *CP/*CF policy shock. Since the bulk of the funding is spent on physical infrastructure (on average, about 60 per cent), the increase is correspondingly greater than for human capital.[41]

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

i. **GDPM** shows the percentage rise in the level of GDP relative to the "no-shock" baseline. It should be stressed that the HERMIN methodology analyses the shift in the level of GDP caused by the *CP/CF* shock. Thus, there can be (and usually is) a semi-permanent rise in the level of GDP as a result of the CSF programmes. But the growth rate of GDP is only boosted temporarily (as the economy adjusts from the lower to the higher level), and there is no long-term rise in the growth rate. A similar point applies to all the impact analysis.[42]

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

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

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

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

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

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

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[41] We stress that the KGINFR and KTRNR measures are constructed in a way that makes them only broad indicators of the unmeasurable underlying reality. For details of the approach, see Bradley, Petrakis and Traistaru, 2004.

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

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

iv. **LPRT** shows the percentage rise in the level of productivity in manufacturing relative to the “no-shock” baseline.

The next set of four variables repeats the previous manufacturing measures, but now applied specifically to the market services sector. It should be stressed that this sector in HERMIN includes all building and construction activities. Consequently, activity in this sector is boosted greatly during the implementation phases of the *CP/CF* programmes, but tends to fall back after the programmes are cut off abruptly a the end of the year 2013.:

i. **ON** shows the percentage rise in the level of GDP in market services relative to the “no-shock” baseline;

ii. **LLN** shows the percentage rise in the level of employment in market services relative to the “no-shock” baseline;

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

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

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

i. **CONS** shows the percentage rise in the level of household consumption relative to the “no-shock” baseline;

ii. **I** shows the percentage rise in the level of total fixed investment relative to the “no-shock” baseline;

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

i. **PGDPFC** shows the percentage rise in the level of the deflator of aggregate GDP relative to the “no-shock” baseline;

ii. **POT** shows the percentage rise in the level of the deflator of manufacturing GDP relative to the “no-shock” baseline;

iii. **PON** shows the percentage rise in the level of the deflator of market services GDP relative to the “no-shock” baseline;

iv. **PCONS** shows the percentage rise in the level of the deflator of household consumption relative to the “no-shock” baseline;

v. **WT** shows the percentage rise in the level of average earnings in manufacturing relative to the “no-shock” baseline;

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

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

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

Table HC4M shows that the impact of the policy shock is very strong while the investment programmes are actually being implemented (i.e., between the years 2007 and 2013). The impact peaks in the year 2013, with an increase of almost 11 per cent in the level of GDP, and of 8.3 per cent in the level of employment. However, when the programme terminates, and the *CP/CF* investment expenditures are assumed (quite unrealistically, of course!) to cease completely, the increase in the level of GDP falls back to about 4.4 per cent.[43] Since the policy impacts are productivity-enhancing, the long-run increase in the level of total employment falls off faster than output, and is only 1.7 per cent by the year 2020. But meanwhile, the level of aggregate productivity has increased by almost 2.8 per cent by 2020.

The simulation results permit us to decompose the aggregate impacts into the separate impacts on manufacturing and on market services.[44] Since building and construction activities are part of the market service sector (N), the impact on output in this sector during the period 2007-13 is very large (peaking at a rise of almost 17 per cent in 2013). But when the programmes cease, the activity level falls off rapidly, and the sustained rise in the level of N-sector GDP is only 3.5 per cent. During the implementation phase, the impact on the level of manufacturing output is also large, and peaks at about 7.5 per cent in 2013. But the rise is more sustained than in market services, and by 2020 manufacturing GDP is still over 5.7 per cent higher than the no-shock baseline. Consequently, even with strong productivity growth, manufacturing employment levels remain almost 3 per cent higher than the baseline for an extended period, but only 1.4 per cent higher in market services.[45]

The implications for the expenditure side of the economy are shown by the impacts on household consumption (CONS) and total fixed investment (I).[46] The boost to consumption is strong, peaking at a rise of about 12 per cent in 2013, but falling off rapidly thereafter, and ending at a rise of just over 4 per cent by the year 2020.. Since the policy shock is one of

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[43] It should be stressed that these impacts are for the "with-CSF" relative to the "without-CSF" simulations. Of course, even in the absence of any CSF, the Czech economy is almost certain to grow, and possibly might grow very strongly. So the CSF-induced rise in the *level* of Czech GDP would be on top on the rise in the level already probably taking place in the no-CSF scenario.

[44] The agriculture sector in HERMIN is fairly static, and tends to function almost independently of the rest of the economy. With no rural aid schemes, it is almost untouched by the policy shock. The government sector is instrumental, and involved to a modest extent in the delivery of training programmes.

[45] It is well known that growth in market service sector activities is likely to be strong in the CEE region. But our simulations are only looking at the specific impacts of a *CP/CF* policy shock, and abstract from these other background changes.

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

increased public investment, the overall impacts on total investment (public and private) is very strong during the implementation years, peaking at a rise of about 27 per cent in 2013, but also falls off to a more modest long-run increase in the level of investment about 3.5 per cent. Obviously in the post-2013 years, this is an increase in purely private sector investment (i.e., manufacturing and market services).

There are some transitory inflationary consequences of the policy shock. Prices in the "exposed" manufacturing sector (POT) are strongly anchored to world prices, so the price level shows only a modest rise caused by a rise in unit labour costs. But the more "sheltered" market services sector (which includes the CSF-induced "booming" building and construction sector) suffers a greater price rise. By the year 2013, the market service sector price level is over 5.3 per cent higher than in the baseline case. Much of this rise comes from wage increases. The level of average annual earnings in manufacturing – a key sector in wage bargaining – is almost 8 per cent higher by the year 2013 than in the baseline case, but the long-run rise is only 2.4 per cent above the baseline level.

Finally, during the programme implementation phase, the trade balance deteriorates relative to the baseline. In the case of the Czech Republic, the deterioration peaks in the year 2009 at a fall of 3.9 percentage points of GDP, but balance is restored after the programme terminates, and there is a small surplus relative to the baseline case.

The need to co-finance the EC contribution places pressure on domestic fiscal policy in the Czech Republic. During the implementation years the public sector borrowing requirement rises by about 3 percentage points of GDP relative to the baseline at the mid-term of the programme, but moves back into approximate balance after 2013 (i.e., relative to the deficit contained in the no-policy baseline).

5.3.2 Summarising country results: cumulative multipliers

One could go through all the detailed simulation results reported in the appendix to this section. What one would find is a mixture of insights about the structure and performance of the economies, but also the specific underlying features and parametrisation of the individual HERMIN models that generate these results.[47] Since it is impossible to carry out rigorous econometric research in any of the new member states, any model-based analysis must be treated with caution.

Perhaps the best summary of how the *CP* and the *CF* policy shocks impact on an economy is given by what we will call the "cumulative" multiplier. The cumulative *CP/*CF (or *CSF*) multiplier attempts to capture the continued (if modest) semi-permanent increase in the level of GDP that should persist after the policy is terminated after the year 2013. Its definition is as follows:

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

[47] Recall that a standard set of "average" externality elasticities were used for all models in the simulations reported in this section. A sensitivity analysis will be carried out in the next section.

The calculation of this multiplier used the simulation results from the Appendix to this section. We illustrate these calculations using the Czech Republic results, and the rest are presented in tables that follow.

In the year 2007, the EC and domestically co-financed expenditures in the Czech Republic amounts to 5.19 per cent of GDP. The impact in that year is to increase GDP by 4.9 per cent. As the programme is implemented over the subsequent years, the annual EC and domestic funding (always expressed as a percentage of GDP) is accumulated, and grows steadily until the year 2013, when it reaches 33.7 per cent of GDP. By that stage, the accumulated percentage increase in GDP reaches 58.2, and the cumulative multiplier is 1.7 (dividing the one by the other gives the value of the "cumulative" multiplier in the year 2013). After 2013, the *CP/CF* expenditures are assumed to terminate abruptly. So, the accumulated *CP/CF* funding is frozen at its value in the year 2013 (i.e., 33.7 per cent of GDP). But the long-run supply-side processes can continue to generate future increases in GDP, even thought the funding has ceased. In the Czech Republic case, the cumulative multiplier continues to increase, and reaches the value of 2.8 by the year 2020.

5.3.3 The cumulative multiplier results

From the tables of cumulative multipliers (Tables 5.1(a) – (f)), the best performer on the basis of the long-run (2020) multiplier value is the Czech Republic (at a long-run value of 2.8). From Table 5.1(a) we see that in the early years of the programme, the initial multipliers start off at the kind of low levels that one tends to find in other small open economies (0.95 in the year 2007). But the supply-side responses in the Czech case are strong, and the multipliers build up steadily to 1.7 in the year 2013, and continue to grow to 2.8 by the year 2020.

From the tables of cumulative multipliers, the next best performer on the basis of the long-run (2020) multiplier value is Slovenia (at a long-run value of 2.5). From Table 5.1(f) we see that in the early years of the programme, the initial multipliers start off at the kind of levels that are somewhat higher than one tends to find in other small open economies (1.41 in the year 2007). The supply-side responses in the Slovenian case are strong, and the multipliers build up steadily to 1.8 in the year 2013, and continue to grow to 2.5 by the year 2020.

The third performer in terms of the size of the long-run cumulative multiplier is Poland, where the multiplier builds up from initial values of 1.3 in the year 2007 to reach 2.4 by the year 2020. The results for Estonia are similar, with initial cumulative multipliers of 1.1, rising to 1.6 by 2013, and reaching 2.3 by 2020. These model results suggest that the Czech Republic, Poland and Estonia have great potential for rapid transitional growth and the possibility of reasonably strong convergence towards the higher EU levels of GDP per head, if the *CP/CF* policies are implemented effectively and efficiently.

The next group of countries have smaller – but still very significant – cumulative multipliers that build up to between about 1.5 and 2.0 by the year 2020. Using the year 2020 cumulative multiplier (in brackets), this group includes Portugal (2.0), Latvia (1.8), Romania (1.8), Spain (1.7), and Hungary (1.6).

The final group of lower "cumulative" multiplier economies includes two regions - East Germany (1.2), and the Italian *Mezzogiorno* (1.1) - and (Greece (0.9).

5.3.4 A note on the revised results

In the first draft of this report, the multiplier results for three countries were considered to be excessively high (Romania, the Czech Republic and Poland), and one was considered excessively low (Greece). The following is an account of the changes that were made to these four HERMIN models in order to address the problem of anomalous multipliers.

<u>Romania</u>:

Of all the existing HERMIN models, the version for Romania is the least robust. Basically, the Romanian economy is rather unstable, in the sense that it is very difficult to recover robust econometric/calibration parameters from the database that is publicly available (covering 1990-1999). There is no accessible fully comprehensive national accounting data more recent than this, to the level of detail needed for a HERMIN model. Basically the transition process that was completed in the new member states by the mid-1990s, appears to be still under way in Romania. It is very difficult to forecast the future performance of the Romanian economy with any degree of confidence. Rather than a HERMIN macro model, where the fully integrated treatment of the supply and demand sides of the model makes life difficult, Romania probably still needs to be studied using the *ad-hoc* models of transition developed by Blanchard (1995) and Roland (2000).

The *CP*/*CF* impacts on Romania contained in the first draft contained an error. The background rate of inflation in Romania is much higher than in any of the other countries being studied. As a consequence, the unit of Romanian currency (the Lei) is very small and conversion of euro to Lei can easily give rise to error of units. In preparing the initial baseline projection for the first draft report, we seriously underestimated the out-of-sample inflation rate (i.e., the rate after the year 1999), and the nominal magnitudes were seriously under predicted. In the revised simulations, a more realistic approach to forecasting the pre-2004 inflation rates was taken.

Extensive experimentation with the model produced more reasonable, but still high, multipliers. One would be tempted to conclude that the model was trying to say that the Romanian economy is so under-developed - with very low levels of physical infrastructure and human capital – that if one hits Romania with a programme of Structural Funds, which are used wisely within the context of a well thought out NDP, then they will probably have a bigger relative impact on Romania than on any other country. However, this assumes that the Romanian public authorities would have the institutional capacity to carry out such a programme. It also assumes that the parametrisation of the Romanian HERMIN model is robust. We do not believe either of these assumptions.

We made two significant changes to the Romanian HERMIN model. First, the parameters on the domestic demand terms in the manufacturing output equation (OT) and the market services output equation (ON) were reduced in size. This has the effect of reducing the Keynesian feedback that operates through the production side. Second, given the very low level of physical infrastructure in Romania (as proxied by the method of stock accumulation described in Section 4 above), we reduced the size of the externality elasticities with respect to physical infrastructure to 0.25 of the values used in all the other models. The alternative would have been to try to derive a more realistic measure of the pre-CSF stock of physical infrastructure, but time did not permit this.

This means that the results for Romania are far less reliable than for the other models. The should be looked on more as speculative explorations that confident predictions.

The Czech Republic and Poland:

In this case, the only change to the two HERMIN models was the reduction in the parameters on the domestic demand terms in the manufacturing output equation (OT). Given reasonably accurate data, it is easier to calibrate the market services output equation (ON). But in the manufacturing output equation (OT), it is sometimes difficult to calibrate accurately the balance between the pure external demand term (OW) and the domestic demand term (FDOT). In the case of Poland, we were able to make use of the new National Accounts (prepared to the ESA 95 standard), and a simple recalibration of the model gave more reasonable – but still high – multipliers. We further reduced the FDOT feedback parameter, and this further reduced the Keynesian feedback that operates through the manufacturing production side. A similar change was made to the Czech Republic model.

Greece:

In the case of Greece, the multipliers appeared to be too low. In part this can be explained by the structure of the Greek economy, the fact that its manufacturing sector has many micro traditional establishments, and the fact that the Greek economy is the least open in the EU (measured in terms of the export/GDP ratio).

We made a change to the parameter in the manufacturing output equation (OT) that had the effect of increasing the Keynesian feedback slightly. This served to increase the multipliers slightly. But this issue may call for a deeper examination, in terms of disaggregation of the Greek HERMIN model, and an improved model of manufacturing output.

General comment on the "new" EU member models:

It should be obvious that it is extremely difficult to calibrate HERMIN models of the "new" and "candidate" EU member states. Three different approaches to model calibration (or estimation) are used in the literature of modelling in the transition economies of the CEE region:

(i) Extending the data sample over different economic regimes

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

(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 1994 data

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

The curve-fitting approach to calibrating the "new" member state HERMIN models relies on judgement, aided by single equation estimation using "ordinary least squares" (OLS). We look to the OLS output to give us some usable curve-fitting information on the values of model parameters that appear to make the behavioural equation roughly congruent with the data. However, we sometimes modify these calibrated parameters in the light of the underlying theoretical implications for the range of values as well as the empirical experience from others modelling exercises in the EU cohesion countries (such as Greece, Ireland and Portugal). Sometimes we impose a particular parameter value for which we have some prior (extra-model) knowledge in order to be able to estimate the remainder of the parameters. On almost all occasions we have therefore run several regressions with modified structure, from which we picked up the one fitting best the underlying assumptions. In a few equations, we are simply unable to calibrate the parameters using OLS, and in those cases we impose values that are plausible in the light of the known characteristics of the economy being modelled. 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.

Table 5.1(a) Cumulative multipliers

	Czech Republic				Estonia		
Year	Cum GDP	Cum CSF	Cum Mult		Cum GDP	Cum CSF	Cum Mult
2006	0.00	0.00	0.00		0.00	0.00	0.00
2007	4.91	5.19	0.95		6.50	5.90	1.10
2008	11.52	10.19	1.13		13.92	11.61	1.20
2009	19.09	15.08	1.27		22.16	17.18	1.29
2010	27.55	19.88	1.39		31.23	22.68	1.38
2011	37.08	24.57	1.51		41.39	28.05	1.48
2012	47.36	29.19	1.62		52.05	33.34	1.56
2013	58.24	33.71	1.73		63.15	38.50	1.64
2014	65.08	33.71	1.93		67.95	38.50	1.76
2015	70.67	33.71	2.10		72.03	38.50	1.87
2016	75.73	33.71	2.25		75.80	38.50	1.97
2017	80.56	33.71	2.39		79.52	38.50	2.07
2018	85.23	33.71	2.53		83.22	38.50	2.16
2019	89.78	33.71	2.66		86.91	38.50	2.26
2020	94.21	33.71	2.79		90.58	38.50	2.35

Table 5.1(b) Cumulative multipliers

	Greece				East Germany		
Year	Cum GDP	Cum CSF	Cum Mult		Cum GDP	Cum CSF	Cum Mult
2006	0	0	0		0.00	0.00	0.00
2007	1.73	2.42	0.72		1.00	1.06	0.94
2008	3.30	4.62	0.72		2.04	2.11	0.96
2009	4.67	6.60	0.71		3.09	3.14	0.99
2010	5.92	8.38	0.71		4.17	4.14	1.01
2011	7.14	9.99	0.71		5.27	5.11	1.03
2012	8.33	11.44	0.73		6.37	6.05	1.05
2013	9.50	12.74	0.75		7.47	6.96	1.07
2014	9.71	12.74	0.76		7.67	6.96	1.10
2015	9.96	12.74	0.78		7.84	6.96	1.13
2016	10.26	12.74	0.81		8.01	6.96	1.15
2017	10.60	12.74	0.83		8.18	6.96	1.17
2018	10.95	12.74	0.86		8.34	6.96	1.20
2019	11.28	12.74	0.89		8.49	6.96	1.22
2020	11.60	12.74	0.91		8.64	6.96	1.24

Table 5.1(c) Cumulative multipliers

	Hungary				Latvia		
Year	Cum GDP	Cum CSF	Cum Mult		Cum GDP	Cum CSF	Cum Mult
2006	0.00	0.00	0.00		0.00	0.00	0.00
2007	3.97	6.18	0.64		8.73	6.38	1.37
2008	8.18	12.28	0.67		17.93	12.85	1.40
2009	13.17	18.47	0.71		27.75	19.40	1.43
2010	19.09	24.78	0.77		38.32	26.02	1.47
2011	26.20	31.21	0.84		49.77	32.73	1.52
2012	33.95	37.63	0.90		61.72	39.52	1.56
2013	42.36	44.03	0.96		74.12	46.37	1.60
2014	46.47	44.03	1.06		75.78	46.37	1.63
2015	50.71	44.03	1.15		77.39	46.37	1.67
2016	54.82	44.03	1.25		78.95	46.37	1.70
2017	58.92	44.03	1.34		80.46	46.37	1.74
2018	63.01	44.03	1.43		81.93	46.37	1.77
2019	67.09	44.03	1.52		83.36	46.37	1.80
2020	71.15	44.03	1.62		84.75	46.37	1.83

Table 5.1(d) Cumulative multipliers

	Mezzogiorno				Portugal		
Year	Cum GDP	Cum CSF	Cum Mult		Cum GDP	Cum CSF	Cum Mult
2006	0.00	0.00	0.00		0.00	0.00	0.00
2007	1.95	2.41	0.81		2.03	2.16	0.94
2008	3.66	4.75	0.77		3.92	4.21	0.93
2009	5.35	7.04	0.76		5.73	6.19	0.93
2010	7.09	9.27	0.76		7.76	8.12	0.96
2011	9.00	11.47	0.78		10.16	9.98	1.02
2012	11.01	13.62	0.81		12.77	11.78	1.08
2013	13.11	15.72	0.83		15.57	13.52	1.15
2014	13.46	15.72	0.86		16.88	13.52	1.25
2015	14.06	15.72	0.89		18.43	13.52	1.36
2016	14.76	15.72	0.94		20.22	13.52	1.50
2017	15.52	15.72	0.99		22.02	13.52	1.63
2018	16.27	15.72	1.03		23.73	13.52	1.76
2019	17.00	15.72	1.08		25.41	13.52	1.88
2020	17.71	15.72	1.13		27.07	13.52	2.00

Table 5.1(e) Cumulative multipliers

	Poland				Romania		
Year	Cum GDP	Cum CSF	Cum Mult		Cum GDP	Cum CSF	Cum Mult
2006	0	0	0		0	0	0
2007	6.77	5.07	1.34		4.80	4.09	1.17
2008	14.13	9.85	1.43		11.21	9.35	1.20
2009	21.99	14.55	1.51		19.72	15.76	1.25
2010	30.43	19.17	1.59		29.08	22.22	1.31
2011	39.65	23.71	1.67		39.49	28.71	1.38
2012	49.20	28.16	1.75		50.57	35.24	1.44
2013	59.05	32.53	1.82		62.32	41.80	1.49
2014	62.63	32.53	1.93		64.04	41.80	1.53
2015	65.66	32.53	2.02		66.32	41.80	1.59
2016	68.53	32.53	2.11		68.40	41.80	1.64
2017	71.33	32.53	2.19		70.40	41.80	1.68
2018	74.08	32.53	2.28		72.30	41.80	1.73
2019	76.78	32.53	2.36		74.13	41.80	1.77
2020	79.44	32.53	2.44		75.87	41.80	1.81

Table 5.1(f) Cumulative multipliers

	Spain				Slovenia		
Year	Cum GDP	Cum CSF	Cum Mult		Cum GDP	Cum CSF	Cum Mult
2006	0.00	0.00	0.00		0	0	0
2007	0.65	0.70	0.93		5.05	3.58	1.41
2008	1.30	1.36	0.96		10.22	7.02	1.46
2009	1.96	1.98	0.99		15.67	10.34	1.51
2010	2.64	2.55	1.03		21.51	13.54	1.59
2011	3.36	3.10	1.09		27.91	16.62	1.68
2012	4.09	3.61	1.14		34.51	19.60	1.76
2013	4.84	4.08	1.19		41.33	22.48	1.84
2014	5.15	4.08	1.26		43.63	22.48	1.94
2015	5.45	4.08	1.33		45.87	22.48	2.04
2016	5.75	4.08	1.41		48.08	22.48	2.14
2017	6.06	4.08	1.49		50.26	22.48	2.24
2018	6.38	4.08	1.56		52.40	22.48	2.33
2019	6.69	4.08	1.64		54.50	22.48	2.42
2020	7.00	4.08	1.71		56.58	22.48	2.52

Appendix S5 Simulation results using "medium" externality elasticities

Variable notation: Qualifiers

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

i. Where there is no qualifier beside the variable name, this means that the results are percentage changes relative to the "no-CSF" baseline;

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

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

iv. Where (d) is shown beside a variable name, this indicates a difference relative to the "no-CSF" baseline. For example, "L(d)" indicates that this is the change in numbers employed (expressed in thousands) in the "with" simulation relative to the "without" simulation.

Variable notation: Names

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

Table HC4M: The Czech Republic -medium value externality elasticities

Date	GDPM (g)	L (g)	GECSFRAE (l)	GECSFRAP (l)	KGINFR	KTRNR	GDPM	L	L (d)	LPROD	OT	LT	LT (d)	LPRT
2006			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	3.19	-0.06	3.11	5.19	3.11	1.25	4.91	5.11	249	0.22	1.69	1.54	24.03	0.15
2008	3.36	-0.01	3.00	5.00	6.07	2.41	6.61	6.32	308	0.31	1.84	1.42	22.33	0.42
2009	3.53	0.03	2.93	4.89	8.97	3.50	7.57	6.89	336	0.61	2.75	1.89	29.99	0.84
2010	3.70	0.08	2.88	4.80	11.83	4.54	8.46	7.25	354	1.10	4.06	2.62	41.71	1.41
2011	3.86	0.12	2.82	4.70	14.66	5.51	9.53	7.62	372	1.77	5.75	3.56	57.10	2.12
2012	4.02	0.16	2.77	4.61	17.48	6.43	10.27	8.02	393	2.06	6.65	4.06	65.68	2.48
2013	4.18	0.21	2.72	4.53	20.27	7.30	10.88	8.30	407	2.33	7.46	4.50	73.30	2.83
2014	4.33	0.25	0.00	0.00	19.63	6.93	6.85	3.64	179	2.67	5.95	3.18	52.12	2.68
2015	4.48	0.29	0.00	0.00	19.05	6.58	5.59	2.52	124	2.91	6.13	3.44	56.84	2.59
2016	4.62	0.32	0.00	0.00	18.51	6.26	5.06	2.06	102	2.94	5.97	3.39	56.27	2.50
2017	4.76	0.36	0.00	0.00	17.99	5.94	4.83	1.88	93.49	2.92	5.80	3.30	55.25	2.42
2018	4.89	0.40	0.00	0.00	17.50	5.65	4.67	1.79	89.18	2.87	5.61	3.20	53.96	2.34
2019	5.02	0.43	0.00	0.00	17.02	5.36	4.55	1.72	86.28	2.81	5.43	3.10	52.63	2.27
2020	5.14	0.46	0.00	0.00	16.56	5.10	4.43	1.67	83.89	2.76	5.26	3.00	51.32	2.19
Date	ON	LLN	LLN (d)	LPRN	CONS	I	PGDPFC	POT	PON	PCONS	WT	NTSVR (d)	GBORR (d)	
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
2007	9.35	9.48	215	-0.13	2.03	20.06	1.70	0.36	1.73	1.47	2.02	-2.81	4.34	
2008	12.28	12.19	276	0.08	6.82	22.19	3.51	0.81	4.07	3.05	4.62	-3.88	3.45	
2009	13.63	13.10	297	0.47	8.34	23.49	4.12	0.90	4.95	3.57	5.54	-3.92	3.01	
2010	14.51	13.37	303	1.01	9.28	24.45	4.23	0.91	5.13	3.67	6.20	-3.77	2.85	
2011	15.39	13.48	305	1.69	10.16	25.48	4.17	0.90	5.10	3.62	6.85	-3.50	2.78	
2012	16.28	13.97	317	2.02	11.17	26.48	4.26	0.92	5.21	3.70	7.35	-3.50	2.66	
2013	16.93	14.25	324	2.35	11.92	27.24	4.34	0.94	5.33	3.77	7.82	-3.45	2.58	
2014	8.15	5.56	127	2.45	10.81	6.96	2.51	0.63	3.82	2.18	5.98	-0.93	-1.45	
2015	5.42	2.94	67.28	2.41	6.46	5.09	0.78	0.20	1.64	0.68	3.64	0.31	-0.77	
2016	4.38	1.99	45.67	2.35	5.19	4.23	0.16	0.09	0.73	0.14	2.98	0.58	-0.36	
2017	3.97	1.65	38.24	2.28	4.66	3.91	-0.04	0.05	0.45	-0.04	2.69	0.67	-0.21	
2018	3.76	1.52	35.22	2.21	4.41	3.73	-0.12	0.04	0.35	-0.10	2.55	0.69	-0.17	
2019	3.61	1.44	33.66	2.14	4.24	3.59	-0.15	0.04	0.32	-0.13	2.46	0.69	-0.16	
2020	3.48	1.39	32.58	2.07	4.11	3.48	-0.17	0.04	0.31	-0.15	2.38	0.68	-0.17	

Table HE4M: Estonia - medium value externality elasticities

Date	GDPM (g)	L (g)	GECSFRAE (l)	GECSFRAP (l)	KGINFR	KTRNR	GDPM	L	L (d)	LPROD	OT	LT	LT (d)	LPRT
2006			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	2.94	-0.08	3.54	5.90	11.06	1.55	6.50	5.14	29.45	1.21	5.95	5.74	7.74	0.19
2008	3.13	0.04	3.42	5.70	20.83	2.96	7.41	5.30	30.41	1.84	7.67	6.71	9.18	0.90
2009	3.33	0.16	3.35	5.58	29.68	4.29	8.24	5.29	30.38	2.63	10.10	8.07	11.23	1.87
2010	3.53	0.29	3.30	5.49	37.86	5.53	9.07	5.15	29.64	3.59	13.01	9.62	13.61	3.09
2011	3.73	0.42	3.23	5.38	45.48	6.69	10.16	5.03	29.09	4.78	16.57	11.51	16.59	4.54
2012	3.94	0.55	3.17	5.28	52.65	7.77	10.66	4.99	29.05	5.31	18.08	12.28	18.07	5.16
2013	4.14	0.69	3.10	5.17	59.44	8.78	11.09	4.94	28.93	5.80	19.41	12.94	19.45	5.73
2014	4.35	0.83	0.00	0.00	56.24	8.33	4.80	0.13	0.76	4.75	13.04	7.14	10.98	5.51
2015	4.56	0.97	0.00	0.00	53.40	7.90	4.08	-0.18	-1.06	4.45	12.09	6.54	10.31	5.21
2016	4.77	1.12	0.00	0.00	50.84	7.49	3.76	-0.28	-1.69	4.26	11.37	6.09	9.86	4.97
2017	4.98	1.26	0.00	0.00	48.50	7.10	3.72	-0.22	-1.35	4.15	10.93	5.88	9.78	4.77
2018	5.19	1.41	0.00	0.00	46.36	6.73	3.70	-0.16	-0.97	4.05	10.54	5.69	9.74	4.59
2019	5.40	1.56	0.00	0.00	44.39	6.38	3.69	-0.09	-0.59	3.96	10.18	5.52	9.74	4.41
2020	5.60	1.71	0.00	0.00	42.57	6.05	3.67	-0.04	-0.22	3.87	9.84	5.36	9.76	4.25
Date	ON	LLN	LLN (d)	LPRN	CONS	I	PGDPFC	POT	PON	PCONS	WT	NTSVR (d)	GBORR (d)	
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
2007	7.51	7.19	20.36	0.30	7.09	23.49	1.56	0.61	1.69	1.25	3.77	-4.08	0.63	
2008	8.24	7.06	19.92	1.10	8.54	24.70	4.23	1.20	5.17	3.41	8.13	-3.84	0.35	
2009	8.62	6.34	17.86	2.14	9.43	25.05	5.25	1.19	6.88	4.22	9.09	-3.31	0.25	
2010	8.82	5.24	14.75	3.41	10.07	24.92	5.07	1.13	6.61	4.08	10.04	-3.02	0.21	
2011	9.11	3.99	11.24	4.93	10.92	24.87	4.80	1.06	6.17	3.86	11.15	-2.70	0.18	
2012	9.22	3.44	9.73	5.59	11.25	24.73	4.56	1.04	5.83	3.67	11.64	-2.55	0.18	
2013	9.26	2.90	8.24	6.18	11.52	24.31	4.43	1.02	5.68	3.56	12.15	-2.33	0.19	
2014	2.10	-3.57	-10.22	5.88	4.29	3.08	2.95	0.46	3.99	2.38	8.35	1.35	-0.42	
2015	1.34	-3.94	-11.38	5.49	2.90	1.70	0.55	-0.12	0.69	0.45	4.46	1.46	-0.16	
2016	1.05	-3.95	-11.54	5.21	2.40	1.18	-0.47	-0.16	-1.07	-0.38	3.99	1.23	-0.07	
2017	1.05	-3.77	-11.13	5.00	2.40	1.17	-0.54	-0.16	-1.14	-0.44	3.83	1.19	-0.05	
2018	1.06	-3.57	-10.72	4.81	2.47	1.15	-0.52	-0.13	-1.04	-0.42	3.80	1.17	-0.06	
2019	1.08	-3.39	-10.33	4.63	2.54	1.14	-0.46	-0.11	-0.89	-0.38	3.78	1.16	-0.07	
2020	1.10	-3.22	-9.99	4.46	2.62	1.12	-0.41	-0.08	-0.74	-0.33	3.76	1.15	-0.08	

Table HG4M: Greece – medium value externality elasticities

Date	GDPM (g)	L (g)	GECSFRAE (l)	GECSFRAP (l)	KGINFR	KTRNR	GDPM	L	L (d)	LPROD	OT	LT	LT (d)	LPRT
2006			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	1.45	0.29	1.45	2.42	0.84	0.34	1.73	1.57	62.66	0.25	2.37	2.70	14.85	-0.32
2008	1.45	0.31	1.32	2.20	1.57	0.62	1.57	1.38	55.14	0.29	1.99	2.18	11.78	-0.18
2009	1.45	0.34	1.19	1.98	2.19	0.87	1.37	1.16	46.44	0.34	1.83	1.88	9.98	-0.05
2010	1.45	0.36	1.07	1.78	2.74	1.07	1.25	0.97	39.31	0.40	1.89	1.81	9.49	0.07
2011	1.46	0.39	0.97	1.61	3.25	1.24	1.22	0.84	33.99	0.48	2.15	1.95	10.05	0.19
2012	1.47	0.41	0.87	1.45	3.70	1.38	1.19	0.76	30.94	0.51	2.28	2.04	10.30	0.23
2013	1.48	0.44	0.78	1.30	4.11	1.49	1.17	0.69	28.10	0.54	2.38	2.11	10.48	0.27
2014	1.50	0.47	0.00	0.00	4.01	1.42	0.21	-0.19	-7.96	0.41	1.10	0.65	3.16	0.46
2015	1.51	0.51	0.00	0.00	3.94	1.34	0.25	-0.17	-6.81	0.40	1.31	0.91	4.37	0.40
2016	1.54	0.54	0.00	0.00	3.88	1.28	0.30	-0.13	-5.20	0.39	1.44	1.08	5.11	0.35
2017	1.56	0.58	0.00	0.00	3.82	1.21	0.34	-0.10	-3.99	0.39	1.50	1.17	5.47	0.33
2018	1.59	0.62	0.00	0.00	3.78	1.15	0.35	-0.09	-3.83	0.39	1.49	1.18	5.41	0.31
2019	1.62	0.66	0.00	0.00	3.73	1.10	0.33	-0.10	-4.13	0.38	1.46	1.15	5.23	0.31
2020	1.66	0.71	0.00	0.00	3.69	1.04	0.32	-0.11	-4.58	0.38	1.42	1.12	5.01	0.30
Date	ON	LLN	LLN (d)	LPRN	CONS	I	PGDPFC	POT	PON	PCONS	WT	NTSVR (d)	GBORR (d)	
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
2007	2.00	2.08	45.54	-0.09	1.27	9.42	0.53	0.28	0.52	0.37	0.77	-1.54	0.63	
2008	1.87	1.86	41.31	0.00	1.34	8.69	1.78	0.68	1.80	1.24	2.43	-1.31	0.63	
2009	1.66	1.54	34.62	0.12	1.15	7.86	2.44	0.75	2.60	1.70	2.84	-0.97	0.59	
2010	1.49	1.23	28.15	0.26	1.01	7.10	2.41	0.70	2.58	1.68	2.76	-0.79	0.58	
2011	1.38	0.97	22.45	0.41	1.02	6.49	2.11	0.60	2.25	1.47	2.52	-0.73	0.57	
2012	1.30	0.82	19.28	0.48	1.07	5.95	1.76	0.52	1.88	1.23	2.22	-0.72	0.55	
2013	1.22	0.68	16.40	0.53	1.12	5.45	1.47	0.44	1.56	1.02	1.98	-0.71	0.52	
2014	0.11	-0.46	-11.12	0.57	0.42	0.07	0.96	0.24	1.04	0.67	1.36	0.09	0.16	
2015	0.10	-0.45	-11.18	0.55	0.36	0.04	0.06	-0.03	0.14	0.04	0.27	0.00	0.12	
2016	0.12	-0.41	-10.31	0.53	0.43	0.06	-0.55	-0.14	-0.54	-0.39	-0.17	-0.15	0.11	
2017	0.15	-0.37	-9.46	0.52	0.50	0.11	-0.79	-0.17	-0.79	-0.55	-0.33	-0.22	0.10	
2018	0.15	-0.36	-9.25	0.51	0.50	0.13	-0.87	-0.18	-0.87	-0.61	-0.38	-0.24	0.10	
2019	0.14	-0.35	-9.35	0.50	0.47	0.12	-0.90	-0.19	-0.91	-0.63	-0.42	-0.24	0.09	
2020	0.13	-0.36	-9.59	0.49	0.43	0.10	-0.94	-0.20	-0.93	-0.66	-0.46	-0.23	0.08	

Table HGE4M: East Germany -medium value externality elasticities

Date	GDPM(g)	L(g)	GECSFRAE(l)	GECSFRAP(l)	KGINFR	KTRNR	GDPM	L	L(d)	LPROD	OT	LT	LT(d)	LPRT
2006			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	1.39	-0.66	0.64	1.06	0.61	0.14	1.00	0.98	69.20	0.02	0.74	0.69	7.85	0.05
2008	1.44	-0.63	0.63	1.05	1.14	0.28	1.04	1.00	69.98	0.05	0.86	0.77	8.65	0.09
2009	1.48	-0.59	0.62	1.03	1.61	0.40	1.05	0.96	67.26	0.09	0.99	0.84	9.43	0.16
2010	1.53	-0.56	0.60	1.00	2.00	0.52	1.07	0.93	64.26	0.15	1.17	0.93	10.46	0.24
2011	1.58	-0.52	0.58	0.97	2.35	0.63	1.10	0.88	61.05	0.22	1.38	1.03	11.68	0.34
2012	1.63	-0.48	0.56	0.94	2.65	0.73	1.10	0.86	58.88	0.25	1.46	1.07	12.12	0.38
2013	1.69	-0.45	0.55	0.91	2.92	0.82	1.10	0.83	56.99	0.27	1.53	1.10	12.51	0.42
2014	1.74	-0.41	0.00	0.00	2.76	0.78	0.20	-0.07	-5.06	0.28	0.82	0.45	5.06	0.37
2015	1.80	-0.37	0.00	0.00	2.61	0.75	0.17	-0.08	-5.53	0.26	0.77	0.42	4.72	0.35
2016	1.86	-0.33	0.00	0.00	2.48	0.71	0.17	-0.07	-4.97	0.25	0.73	0.40	4.52	0.34
2017	1.92	-0.28	0.00	0.00	2.36	0.68	0.16	-0.07	-4.51	0.24	0.70	0.38	4.33	0.32
2018	1.98	-0.24	0.00	0.00	2.24	0.65	0.16	-0.06	-4.10	0.23	0.67	0.36	4.16	0.30
2019	2.04	-0.20	0.00	0.00	2.14	0.62	0.16	-0.06	-3.72	0.22	0.64	0.35	3.99	0.29
2020	2.10	-0.15	0.00	0.00	2.04	0.59	0.15	-0.05	-3.38	0.21	0.61	0.33	3.84	0.28
Date	ON	LLN	LLN(d)	LPRN	CONS	I	PGDPFC	POT	PON	PCONS	WT	NTSVR(d)	GBORR(d)	
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
2007	0.81	0.78	31.41	0.03	0.94	2.39	0.00	0.00	-0.01	0.00	0.01	-0.54	0.15	
2008	0.86	0.79	31.29	0.07	1.00	2.42	-0.02	0.00	-0.04	0.00	0.02	-0.55	0.15	
2009	0.86	0.73	28.57	0.13	1.01	2.37	-0.03	0.00	-0.09	0.00	0.03	-0.53	0.15	
2010	0.86	0.65	25.35	0.21	1.01	2.32	-0.06	0.00	-0.15	0.00	0.05	-0.51	0.15	
2011	0.87	0.56	21.72	0.31	1.02	2.27	-0.08	0.00	-0.22	0.00	0.07	-0.49	0.15	
2012	0.86	0.52	19.83	0.34	1.01	2.23	-0.10	0.00	-0.25	0.00	0.08	-0.48	0.15	
2013	0.86	0.48	18.25	0.38	1.01	2.18	-0.10	0.00	-0.28	0.00	0.09	-0.46	0.15	
2014	0.09	-0.26	-9.91	0.35	0.10	0.01	-0.11	0.00	-0.27	0.00	0.08	0.03	0.02	
2015	0.07	-0.26	-9.96	0.33	0.07	0.00	-0.10	0.00	-0.26	0.00	0.08	0.04	0.01	
2016	0.07	-0.25	-9.24	0.31	0.07	0.00	-0.09	0.00	-0.24	0.00	0.07	0.04	0.01	
2017	0.07	-0.23	-8.63	0.30	0.07	0.00	-0.08	0.00	-0.23	0.00	0.07	0.04	0.01	
2018	0.07	-0.22	-8.08	0.29	0.07	0.01	-0.08	0.00	-0.22	0.00	0.07	0.04	0.01	
2019	0.07	-0.21	-7.56	0.27	0.07	0.01	-0.07	0.00	-0.21	0.00	0.06	0.04	0.01	
2020	0.07	-0.19	-7.10	0.26	0.07	0.01	-0.07	0.00	-0.20	0.00	0.06	0.04	0.01	

Table HH4M: Hungary -medium value externality elasticities

Date	GDPM(g)	L(g)	GECSFRAE(l)	GECSFRAP(l)	KGINFR	KTRNR	GDPM	L	L(d)	LPROD	OT	LT	LT(d)	LPRT
2006			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	2.48	-0.72	3.71	6.18	5.07	1.20	3.97	3.80	138	0.36	1.14	0.94	8.43	0.20
2008	2.63	-0.69	3.66	6.11	10.01	2.33	4.21	3.70	134	0.63	1.42	0.75	6.73	0.67
2009	2.78	-0.66	3.71	6.19	14.96	3.43	4.99	3.97	143	1.15	2.75	1.45	12.91	1.29
2010	2.94	-0.63	3.79	6.31	19.97	4.51	5.92	4.14	148	1.91	4.51	2.37	21.04	2.09
2011	3.09	-0.60	3.86	6.43	25.04	5.58	7.11	4.30	153	2.95	6.76	3.54	31.22	3.11
2012	3.25	-0.58	3.85	6.42	30.06	6.59	7.75	4.39	155	3.51	7.92	4.12	36.21	3.64
2013	3.41	-0.55	3.84	6.40	35.03	7.57	8.42	4.49	157	4.08	9.04	4.71	41.11	4.14
2014	3.57	-0.52	0.00	0.00	33.84	7.19	4.10	-0.14	-4.74	4.47	7.55	3.48	30.26	3.93
2015	3.74	-0.50	0.00	0.00	32.75	6.83	4.24	0.03	1.13	4.53	7.89	4.05	35.01	3.69
2016	3.90	-0.47	0.00	0.00	31.72	6.49	4.12	-0.08	-2.65	4.51	7.59	3.92	33.74	3.53
2017	4.06	-0.45	0.00	0.00	30.73	6.16	4.10	-0.08	-2.80	4.50	7.35	3.80	32.55	3.42
2018	4.22	-0.42	0.00	0.00	29.78	5.86	4.09	-0.08	-2.71	4.48	7.12	3.69	31.41	3.31
2019	4.38	-0.40	0.00	0.00	28.87	5.56	4.08	-0.08	-2.60	4.45	6.89	3.58	30.30	3.20
2020	4.54	-0.38	0.00	0.00	27.99	5.28	4.06	-0.07	-2.48	4.42	6.68	3.47	29.24	3.10
Date	ON	LLN	LLN(d)	LPRN	CONS	I	PGDPFC	POT	PON	PCONS	WT	NTSVR(d)	GBORR(d)	
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
2007	7.92	7.66	121	0.24	2.64	30.93	3.47	1.83	3.15	2.59	5.45	-3.85	1.05	
2008	8.31	7.53	118	0.73	3.26	33.05	7.56	3.57	8.31	5.62	11.13	-3.32	0.45	
2009	9.17	7.72	121	1.35	3.77	35.26	8.44	3.49	10.18	6.26	11.57	-3.02	0.27	
2010	9.86	7.55	117	2.15	4.43	37.16	8.40	3.50	10.11	6.24	12.50	-2.97	0.12	
2011	10.63	7.23	112	3.17	5.10	39.31	8.21	3.42	9.98	6.10	13.37	-2.81	0.04	
2012	11.04	7.08	109	3.69	5.46	40.58	8.07	3.41	9.86	6.00	13.90	-2.73	-0.02	
2013	11.45	6.97	107	4.18	5.86	41.78	7.91	3.37	9.78	5.88	14.33	-2.64	-0.06	
2014	1.53	-2.30	-35.00	3.92	2.33	2.73	3.31	1.22	5.87	2.47	7.55	1.81	-1.28	
2015	1.35	-2.23	-33.88	3.66	1.60	1.51	-1.14	-0.83	-0.09	-0.86	1.29	1.60	-0.65	
2016	1.00	-2.41	-36.38	3.49	1.51	0.84	-2.02	-0.76	-2.17	-1.52	1.31	1.36	-0.47	
2017	0.96	-2.35	-35.35	3.38	1.40	0.85	-2.08	-0.79	-2.16	-1.57	1.12	1.36	-0.37	
2018	0.93	-2.27	-34.12	3.27	1.38	0.81	-2.10	-0.77	-2.15	-1.58	1.07	1.33	-0.35	
2019	0.90	-2.20	-32.90	3.17	1.36	0.79	-2.08	-0.75	-2.09	-1.57	1.04	1.30	-0.33	
2020	0.88	-2.13	-31.71	3.07	1.34	0.77	-2.06	-0.72	-2.02	-1.55	1.01	1.27	-0.32	

Table HL4M: Latvia - medium value externality elasticities

Date	GDPM(g)	L(g)	GECSFRAE(l)	GECSFRAP(l)	KGINFR	KTRNR	GDPM	L	L(d)	LPROD	OT	LT	LT(d)	LPRT
2006			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	2.82	0.41	3.83	6.38	9.39	1.77	8.73	6.48	63.45	2.24	4.43	4.23	7.41	0.19
2008	2.89	0.46	3.88	6.46	17.79	3.50	9.20	6.51	64.04	2.67	5.67	4.86	8.55	0.77
2009	2.97	0.52	3.93	6.55	25.40	5.21	9.82	6.47	63.97	3.32	7.53	5.78	10.20	1.65
2010	3.05	0.57	3.98	6.63	32.39	6.90	10.57	6.37	63.35	4.15	9.95	6.97	12.34	2.79
2011	3.13	0.63	4.02	6.70	38.88	8.55	11.45	6.23	62.30	5.16	12.90	8.39	14.92	4.16
2012	3.22	0.70	4.08	6.79	44.95	10.19	11.95	6.25	62.94	5.63	14.27	9.08	16.21	4.76
2013	3.31	0.77	4.11	6.85	50.64	11.80	12.39	6.25	63.48	6.05	15.54	9.71	17.42	5.32
2014	3.41	0.84	0.00	0.00	47.67	11.23	1.66	-1.55	-15.88	3.48	9.67	4.36	7.87	5.08
2015	3.51	0.92	0.00	0.00	44.96	10.67	1.61	-1.49	-15.37	3.35	9.22	4.18	7.59	4.84
2016	3.61	1.00	0.00	0.00	42.50	10.14	1.56	-1.43	-14.96	3.22	8.80	4.01	7.32	4.61
2017	3.72	1.09	0.00	0.00	40.23	9.64	1.51	-1.38	-14.55	3.11	8.41	3.85	7.07	4.39
2018	3.84	1.18	0.00	0.00	38.15	9.15	1.47	-1.33	-14.18	3.00	8.04	3.69	6.85	4.19
2019	3.96	1.28	0.00	0.00	36.23	8.69	1.43	-1.28	-13.84	2.89	7.69	3.55	6.64	4.00
2020	4.10	1.39	0.00	0.00	34.45	8.25	1.39	-1.23	-13.52	2.79	7.37	3.42	6.44	3.82
Date	ON	LLN	LLN(d)	LPRN	CONS	I	PGDPFC	POT	PON	PCONS	WT	NTSVR(d)	GBORR(d)	
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
2007	11.30	11.59	53.52	-0.26	8.94	27.91	-0.13	-0.05	0.18	-0.10	-0.02	-3.86	0.03	
2008	11.69	11.30	52.92	0.34	9.25	28.30	-0.46	-0.18	-0.25	-0.37	-0.05	-3.85	-0.35	
2009	12.16	10.76	51.12	1.26	9.64	28.64	-1.16	-0.41	-1.19	-0.94	-0.26	-3.88	-0.26	
2010	12.69	10.02	48.29	2.43	10.10	28.91	-2.10	-0.72	-2.47	-1.70	-0.55	-3.92	-0.15	
2011	13.31	9.10	44.59	3.85	10.67	29.14	-3.19	-1.08	-3.99	-2.59	-0.90	-3.95	-0.04	
2012	13.67	8.80	43.86	4.48	10.95	29.46	-3.94	-1.28	-5.00	-3.20	-1.28	-4.05	0.06	
2013	13.98	8.50	43.11	5.05	11.23	29.57	-4.46	-1.44	-5.72	-3.62	-1.50	-4.07	0.17	
2014	0.50	-4.60	-23.75	5.34	-0.55	-0.92	-3.87	-1.31	-5.77	-3.14	-1.10	0.51	0.10	
2015	0.51	-4.35	-22.96	5.08	-0.47	-0.84	-3.72	-1.25	-5.55	-3.02	-1.07	0.48	0.68	
2016	0.50	-4.14	-22.28	4.83	-0.40	-0.80	-3.53	-1.19	-5.29	-2.86	-1.01	0.46	0.63	
2017	0.49	-3.93	-21.63	4.60	-0.33	-0.75	-3.35	-1.13	-5.04	-2.71	-0.94	0.45	0.58	
2018	0.49	-3.73	-21.03	4.39	-0.26	-0.71	-3.17	-1.08	-4.80	-2.57	-0.88	0.44	0.53	
2019	0.49	-3.54	-20.47	4.18	-0.20	-0.67	-3.01	-1.03	-4.57	-2.44	-0.82	0.42	0.48	
2020	0.49	-3.37	-19.96	3.99	-0.13	-0.63	-2.86	-0.98	-4.36	-2.32	-0.77	0.41	0.44	

Table HMZ4M: The Italian *Mezzogiorno* - medium value externality elasticities

Date	GDPM(g)	L(g)	GECSFRAE(l)	GECSFRAP(l)	KGINFR	KTRNR	GDPM	L	L(d)	LPROD	OT	LT	LT(d)	LPRT
2006			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	2.08	0.24	1.45	2.41	1.17	0.42	1.95	1.72	115	0.23	1.51	1.37	12.65	0.14
2008	2.10	0.26	1.41	2.34	2.25	0.80	1.71	1.42	95.00	0.29	0.72	0.51	4.78	0.21
2009	2.12	0.28	1.37	2.28	3.25	1.16	1.69	1.29	86.37	0.39	0.75	0.39	3.66	0.36
2010	2.13	0.29	1.34	2.24	4.19	1.50	1.75	1.20	80.84	0.54	1.18	0.62	5.79	0.56
2011	2.15	0.31	1.32	2.19	5.09	1.82	1.90	1.17	79.13	0.72	1.87	1.05	9.90	0.82
2012	2.17	0.32	1.29	2.15	5.94	2.11	2.01	1.18	79.87	0.82	2.29	1.33	12.63	0.94
2013	2.18	0.34	1.26	2.11	6.75	2.39	2.11	1.18	80.44	0.91	2.65	1.57	15.00	1.06
2014	2.20	0.35	0.00	0.00	6.50	2.27	0.34	-0.36	-24.38	0.70	1.33	0.39	3.75	0.93
2015	2.22	0.37	0.00	0.00	6.27	2.16	0.60	-0.09	-6.38	0.70	2.16	1.23	11.80	0.92
2016	2.23	0.38	0.00	0.00	6.07	2.05	0.70	0.02	1.11	0.68	2.40	1.49	14.41	0.90
2017	2.25	0.40	0.00	0.00	5.88	1.95	0.75	0.08	5.72	0.67	2.42	1.54	14.94	0.87
2018	2.27	0.41	0.00	0.00	5.69	1.85	0.75	0.09	6.51	0.65	2.34	1.48	14.49	0.84
2019	2.28	0.42	0.00	0.00	5.51	1.76	0.73	0.09	6.46	0.64	2.24	1.42	13.94	0.81
2020	2.30	0.44	0.00	0.00	5.34	1.67	0.71	0.09	6.32	0.62	2.16	1.36	13.45	0.78
Date	ON	LLN	LLN(d)	LPRN	CONS	I	PGDPFC	POT	PON	PCONS	WT	NTSVR(d)	GBORR(d)	
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
2007	2.69	2.59	96.18	0.09	1.38	12.10	0.54	0.00	0.50	0.49	1.25	-1.36	-0.89	
2008	2.49	2.26	84.31	0.23	1.27	12.02	1.67	0.00	1.80	1.50	2.90	-1.48	-1.03	
2009	2.44	2.04	76.87	0.39	1.09	11.93	2.32	0.00	2.79	2.08	3.36	-1.21	-1.03	
2010	2.41	1.82	69.28	0.58	1.01	11.75	2.36	0.00	2.88	2.12	3.38	-1.04	-1.03	
2011	2.47	1.66	63.53	0.80	1.10	11.65	2.18	0.00	2.64	1.95	3.26	-0.93	-0.99	
2012	2.52	1.59	61.59	0.91	1.19	11.55	1.95	0.00	2.32	1.74	3.09	-0.90	-0.96	
2013	2.56	1.53	59.86	1.01	1.29	11.45	1.77	0.00	2.07	1.58	2.98	-0.88	-0.92	
2014	0.20	-0.71	-28.13	0.92	0.10	0.49	1.23	0.00	1.47	1.10	1.78	0.27	-0.08	
2015	0.39	-0.46	-18.18	0.85	0.26	0.37	0.21	0.00	0.26	0.19	0.32	0.43	0.09	
2016	0.47	-0.33	-13.30	0.80	0.50	0.31	-0.39	0.00	-0.67	-0.35	-0.07	0.24	0.13	
2017	0.54	-0.23	-9.22	0.77	0.66	0.38	-0.51	0.00	-0.87	-0.46	-0.11	0.14	0.18	
2018	0.55	-0.20	-7.98	0.75	0.69	0.39	-0.49	0.00	-0.85	-0.44	-0.07	0.11	0.18	
2019	0.54	-0.18	-7.48	0.72	0.68	0.39	-0.45	0.00	-0.79	-0.40	-0.04	0.11	0.17	
2020	0.52	-0.17	-7.13	0.70	0.66	0.38	-0.42	0.00	-0.74	-0.37	-0.02	0.11	0.17	

Table HP4M: Portugal -medium value externality elasticities

Date	GDPM(g)	L(g)	GECSFRAE(l)	GECSFRAP(l)	KGINFR	KTRNR	GDPM	L	L(d)	LPROD	OT	LT	LT(d)	LPRT
2006			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	2.98	-0.08	1.29	2.16	1.75	1.50	2.03	1.62	79.05	0.55	1.48	1.52	15.33	-0.04
2008	2.98	-0.08	1.23	2.05	3.24	2.84	1.89	1.39	67.90	0.66	1.33	1.14	11.58	0.19
2009	2.97	-0.08	1.19	1.98	4.59	4.07	1.81	1.21	58.73	0.82	1.80	1.35	13.88	0.44
2010	2.95	-0.08	1.16	1.93	5.83	5.20	2.02	1.16	56.21	1.08	2.64	1.88	19.40	0.75
2011	2.94	-0.09	1.12	1.86	6.97	6.23	2.40	1.17	56.70	1.42	3.73	2.57	26.73	1.13
2012	2.92	-0.09	1.08	1.80	8.02	7.16	2.62	1.19	57.94	1.58	4.24	2.91	30.50	1.29
2013	2.91	-0.09	1.04	1.74	8.99	8.01	2.79	1.21	58.62	1.72	4.69	3.20	33.78	1.45
2014	2.89	-0.10	0.00	0.00	8.52	7.61	1.31	0.03	1.41	1.27	3.54	2.07	22.05	1.44
2015	2.87	-0.10	0.00	0.00	8.12	7.23	1.55	0.23	11.14	1.25	3.87	2.52	27.01	1.32
2016	2.85	-0.11	0.00	0.00	7.76	6.86	1.80	0.40	19.44	1.24	3.91	2.63	28.41	1.25
2017	2.83	-0.12	0.00	0.00	7.41	6.52	1.80	0.44	21.04	1.21	3.76	2.54	27.62	1.19
2018	2.81	-0.12	0.00	0.00	7.07	6.20	1.71	0.41	19.96	1.15	3.56	2.39	26.26	1.14
2019	2.79	-0.13	0.00	0.00	6.76	5.89	1.67	0.42	20.34	1.11	3.43	2.32	25.58	1.09
2020	2.77	-0.13	0.00	0.00	6.47	5.59	1.66	0.44	21.24	1.08	3.31	2.25	25.06	1.03
Date	ON	LLN	LLN(d)	LPRN	CONS	I	PGDPFC	POT	PON	PCONS	WT	NTSVR(d)	GBORR(d)	
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
2007	2.77	2.67	60.34	0.10	1.44	6.85	1.52	1.55	1.22	1.22	2.89	-1.18	0.52	
2008	2.65	2.36	53.13	0.28	1.50	6.56	3.91	2.90	3.94	3.12	5.70	-0.81	0.53	
2009	2.43	1.87	41.75	0.55	1.14	6.28	4.28	2.49	5.05	3.41	5.18	-0.31	0.46	
2010	2.43	1.52	33.81	0.90	1.34	6.15	3.80	2.25	4.39	3.03	5.05	-0.29	0.53	
2011	2.56	1.22	27.07	1.32	1.87	6.10	3.63	2.20	4.05	2.89	5.35	-0.28	0.55	
2012	2.65	1.12	24.64	1.51	2.25	6.06	3.63	2.24	3.99	2.89	5.59	-0.28	0.57	
2013	2.71	1.01	22.13	1.68	2.57	5.99	3.68	2.27	4.04	2.93	5.82	-0.25	0.59	
2014	0.61	-0.95	-20.64	1.57	1.77	0.14	2.58	1.15	3.17	2.06	3.65	0.59	0.15	
2015	0.75	-0.74	-15.87	1.49	2.06	0.25	0.90	0.23	1.25	0.72	1.75	0.31	0.11	
2016	1.00	-0.42	-8.97	1.43	2.67	0.43	0.76	0.58	0.54	0.61	2.35	-0.05	0.15	
2017	1.05	-0.31	-6.58	1.37	2.77	0.48	1.14	0.77	1.07	0.91	2.66	-0.02	0.11	
2018	1.00	-0.30	-6.29	1.30	2.62	0.45	1.26	0.78	1.29	1.00	2.63	0.04	0.10	
2019	0.99	-0.25	-5.23	1.24	2.57	0.45	1.24	0.77	1.30	0.99	2.55	0.04	0.10	
2020	1.00	-0.18	-3.82	1.19	2.57	0.47	1.25	0.80	1.32	1.00	2.55	0.03	0.09	

Table HPO4M: Poland – medium-value externality elasticities

Date	GDPM (g)	L (g)	GECSFRAE (l)	GECSFRAP (l)	KGINFR	KTRNR	GDPM	L	L (d)	LPROD	OT	LT	LT (d)	LPRT
2006			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	3.04	0.09	3.04	5.07	7.61	1.19	6.77	4.88	654	1.65	6.00	5.74	141	0.24
2008	3.07	0.12	2.87	4.78	14.54	2.24	7.36	4.85	650	2.10	6.53	5.67	138	0.82
2009	3.11	0.16	2.82	4.70	21.17	3.22	7.86	4.71	632	2.75	8.40	6.70	162	1.59
2010	3.14	0.19	2.77	4.62	27.55	4.14	8.44	4.49	605	3.59	10.79	8.02	192	2.56
2011	3.17	0.22	2.72	4.54	33.74	5.00	9.22	4.26	574	4.65	13.78	9.69	230	3.73
2012	3.21	0.25	2.67	4.46	39.73	5.79	9.55	4.10	555	5.17	15.16	10.44	246	4.27
2013	3.24	0.29	2.62	4.37	45.54	6.53	9.85	3.95	536	5.67	16.43	11.13	260	4.77
2014	3.28	0.32	0.00	0.00	43.83	6.20	3.58	-0.37	-50.74	4.13	10.49	5.68	132	4.56
2015	3.33	0.36	0.00	0.00	42.32	5.89	3.03	-0.60	-81.64	3.98	10.48	5.91	136	4.31
2016	3.37	0.40	0.00	0.00	40.91	5.60	2.87	-0.64	-87.85	3.87	10.07	5.71	130	4.13
2017	3.41	0.44	0.00	0.00	39.59	5.32	2.80	-0.64	-87.79	3.80	9.77	5.55	126	4.00
2018	3.46	0.48	0.00	0.00	38.35	5.05	2.75	-0.63	-87.20	3.74	9.49	5.41	122	3.87
2019	3.51	0.52	0.00	0.00	37.19	4.80	2.70	-0.62	-86.59	3.68	9.22	5.27	118	3.76
2020	3.57	0.56	0.00	0.00	36.09	4.56	2.66	-0.62	-86.07	3.63	8.97	5.14	115	3.65

Date	ON	LLN	LLN (d)	LPRN	CONS	I	PGDPFC	POT	PON	PCONS	WT	NTSVR (d)	GBORR (d)
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	8.55	8.42	489	0.12	7.72	31.52	4.58	1.30	5.06	2.84	5.21	-2.99	-0.59
2008	9.15	8.42	490	0.67	9.27	31.97	8.53	2.45	9.61	5.26	10.37	-2.52	-1.15
2009	9.25	7.70	449	1.44	9.47	32.13	7.70	2.21	8.69	4.75	10.25	-2.47	-1.24
2010	9.26	6.69	391	2.41	9.64	31.67	6.43	1.86	7.29	3.97	9.87	-2.37	-1.22
2011	9.29	5.51	323	3.59	9.88	31.15	4.85	1.42	5.58	3.01	9.36	-2.26	-1.19
2012	9.24	4.90	288	4.13	9.90	30.61	3.91	1.17	4.58	2.43	8.90	-2.18	-1.16
2013	9.17	4.33	255	4.64	9.93	29.95	3.07	0.94	3.71	1.91	8.51	-2.08	-1.12
2014	1.31	-3.08	-182	4.53	2.61	1.69	-1.01	-0.25	-0.87	-0.63	3.60	0.47	-0.78
2015	0.50	-3.66	-218	4.32	1.05	0.36	-4.74	-1.39	-5.10	-2.99	-1.02	0.29	-0.31
2016	0.35	-3.65	-218	4.15	0.85	-0.18	-4.97	-1.44	-5.32	-3.14	-1.39	0.31	-0.18
2017	0.32	-3.56	-214	4.02	0.79	-0.23	-5.00	-1.44	-5.31	-3.16	-1.51	0.29	-0.16
2018	0.30	-3.46	-209	3.90	0.76	-0.25	-5.00	-1.43	-5.26	-3.16	-1.57	0.28	-0.14
2019	0.28	-3.37	-205	3.78	0.73	-0.25	-5.00	-1.41	-5.21	-3.16	-1.63	0.26	-0.12
2020	0.27	-3.28	-201	3.67	0.70	-0.26	-5.01	-1.40	-5.17	-3.16	-1.69	0.25	-0.11

Table HR4M: Romania – medium-value externality elasticities

Date	GDPM (g)	L (g)	GECSFRAE (l)	GECSFRAP (l)	KGINFR ***	KTRNR	GDPM	L	L (d)	LPROD	OT	LT	LT (d)	LPRT
2006			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	3.73	1.08	2.45	4.09	19.75	1.03	4.80	2.56	226	2.48	2.61	2.35	44.18	0.25
2008	3.79	1.11	3.16	5.26	44.60	2.35	6.41	3.32	296	3.38	4.04	3.36	62.96	0.66
2009	3.85	1.15	3.85	6.41	74.68	3.96	8.52	4.25	383	4.59	6.29	4.86	90.88	1.37
2010	3.92	1.19	3.88	6.46	104	5.53	9.36	4.40	402	5.27	8.29	5.92	111	2.24
2011	3.98	1.23	3.89	6.49	133	7.08	10.41	4.59	425	6.12	10.77	7.23	135	3.30
2012	4.05	1.27	3.92	6.53	161	8.60	11.08	4.78	448	6.59	12.00	7.90	148	3.79
2013	4.12	1.31	3.94	6.56	189	10.10	11.75	4.98	472	7.03	13.15	8.54	159	4.24
2014	4.19	1.36	0.00	0.00	180	9.60	1.72	-0.49	-47.53	2.35	7.68	3.69	68.88	3.85
2015	4.26	1.40	0.00	0.00	171	9.12	2.28	-0.18	-17.19	2.57	7.83	3.94	73.57	3.74
2016	4.33	1.45	0.00	0.00	163	8.66	2.08	-0.26	-25.80	2.45	7.46	3.73	69.60	3.60
2017	4.41	1.51	0.00	0.00	156	8.23	2.00	-0.28	-28.39	2.38	7.19	3.59	67.07	3.47
2018	4.49	1.56	0.00	0.00	148	7.82	1.91	-0.31	-31.67	2.31	6.92	3.46	64.52	3.35
2019	4.57	1.62	0.00	0.00	142	7.43	1.82	-0.34	-34.81	2.25	6.66	3.32	62.11	3.23
2020	4.65	1.68	0.00	0.00	135	7.05	1.74	-0.36	-37.94	2.18	6.41	3.20	59.81	3.12

Date	ON	LLN	LLN (d)	LPRN	CONS	I	PGDPFC	POT	PON	PCONS	WT	NTSVR (d)	GBORR (d)	
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
2007	6.76	6.71	169	0.04	2.23	26.41	0.23	-0.10	0.04	0.18	0.08	-2.59	1.56	
2008	8.73	8.32	216	0.38	2.60	34.45	0.12	-0.27	-0.16	0.09	0.22	-2.97	1.84	
2009	11.17	10.08	271	0.99	3.53	43.31	-0.12	-0.55	-0.53	-0.10	0.47	-3.62	2.29	
2010	11.68	9.69	270	1.82	3.78	44.50	-0.56	-0.89	-1.05	-0.43	0.77	-3.53	2.30	
2011	12.34	9.27	267	2.81	4.25	45.87	-1.08	-1.30	-1.66	-0.84	1.14	-3.55	2.37	
2012	12.85	9.28	277	3.27	4.53	47.07	-1.32	-1.48	-1.94	-1.03	1.32	-3.26	2.42	
2013	13.38	9.35	289	3.68	4.85	48.20	-1.54	-1.65	-2.18	-1.20	1.48	-3.11	2.47	
2014	-0.09	-3.63	-116	3.67	-0.41	0.19	-2.05	-1.49	-2.29	-1.60	1.35	1.78	0.03	
2015	0.71	-2.73	-90.76	3.54	0.82	1.12	-1.97	-1.44	-2.20	-1.54	1.32	0.86	0.46	
2016	0.55	-2.77	-95.40	3.41	0.60	0.89	-1.92	-1.38	-2.11	-1.50	1.28	0.71	0.37	
2017	0.54	-2.67	-95.46	3.29	0.60	0.83	-1.87	-1.33	-2.03	-1.46	1.24	0.58	0.37	
2018	0.50	-2.59	-96.19	3.17	0.58	0.75	-1.82	-1.28	-1.95	-1.42	1.21	0.51	0.35	
2019	0.48	-2.51	-96.92	3.06	0.55	0.69	-1.77	-1.23	-1.88	-1.38	1.17	0.47	0.34	
2020	0.45	-2.43	-97.75	2.95	0.53	0.62	-1.72	-1.18	-1.80	-1.34	1.14	0.43	0.33	

*** Note: The CSF-induced rise in KGINFR (the ratio of the post-CSF to the pre-CSF physical infrastructure) is excessively high. It proved difficult to calibrate the level of this stock. As mentioned earlier in the text, we compensated by reducing the size of the externality elasticity.

Table HS4M: Spain - medium value externality elasticities														
Date	GDPM(g)	L(g)	GECSFRAE(l)	GECSFRAP(l)	KGINFR	KTRNR	GDPM	L	L(d)	LPROD	OT	LT	LT(d)	LPRT
2006			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	2.09	0.86	0.42	0.70	0.41	0.33	0.65	0.54	89.45	0.12	0.64	0.59	19.19	0.04
2008	2.09	0.87	0.40	0.66	0.78	0.63	0.65	0.51	85.68	0.15	0.69	0.60	19.75	0.09
2009	2.08	0.88	0.37	0.62	1.12	0.90	0.66	0.47	79.42	0.20	0.80	0.64	21.26	0.15
2010	2.07	0.89	0.35	0.58	1.44	1.12	0.68	0.43	72.53	0.27	0.96	0.71	23.97	0.24
2011	2.07	0.90	0.33	0.54	1.73	1.32	0.72	0.38	65.83	0.35	1.17	0.82	27.93	0.35
2012	2.07	0.91	0.30	0.51	2.00	1.49	0.73	0.36	62.47	0.38	1.27	0.87	30.11	0.39
2013	2.07	0.92	0.29	0.48	2.26	1.64	0.75	0.34	59.60	0.42	1.36	0.92	32.28	0.43
2014	2.07	0.94	0.00	0.00	2.21	1.54	0.30	-0.04	-7.48	0.34	0.93	0.52	18.60	0.40
2015	2.07	0.95	0.00	0.00	2.17	1.46	0.30	-0.03	-5.82	0.33	0.93	0.54	19.45	0.39
2016	2.08	0.96	0.00	0.00	2.14	1.37	0.31	-0.02	-4.01	0.33	0.93	0.55	20.12	0.38
2017	2.08	0.97	0.00	0.00	2.11	1.30	0.31	-0.01	-2.26	0.32	0.92	0.56	20.62	0.37
2018	2.09	0.99	0.00	0.00	2.08	1.22	0.31	-0.01	-1.03	0.31	0.91	0.56	20.91	0.35
2019	2.10	1.00	0.00	0.00	2.05	1.15	0.31	0.00	-0.17	0.31	0.90	0.55	21.07	0.34
2020	2.11	1.01	0.00	0.00	2.03	1.09	0.31	0.00	0.44	0.30	0.88	0.55	21.13	0.33
Date	ON	LLN	LLN(d)	LPRN	CONS	I	PGDPFC	POT	PON	PCONS	WT	NTSVR(d)	GBORR(d)	
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
2007	0.72	0.68	66.67	0.04	0.56	2.39	0.08	0.07	0.05	0.07	0.15	-0.46	0.14	
2008	0.71	0.63	62.50	0.08	0.58	2.30	0.20	0.18	0.17	0.18	0.33	-0.43	0.14	
2009	0.69	0.55	54.92	0.14	0.59	2.18	0.28	0.21	0.27	0.25	0.44	-0.39	0.13	
2010	0.68	0.45	45.51	0.23	0.61	2.06	0.27	0.16	0.27	0.24	0.47	-0.35	0.12	
2011	0.66	0.34	35.01	0.32	0.64	1.95	0.18	0.07	0.19	0.16	0.44	-0.31	0.12	
2012	0.65	0.28	29.63	0.37	0.65	1.86	0.05	-0.04	0.05	0.05	0.34	-0.29	0.12	
2013	0.64	0.23	24.73	0.41	0.67	1.77	-0.08	-0.14	-0.08	-0.07	0.24	-0.28	0.12	
2014	0.13	-0.24	-26.08	0.38	0.29	0.12	-0.25	-0.27	-0.24	-0.23	0.03	0.02	0.01	
2015	0.13	-0.23	-25.27	0.36	0.28	0.10	-0.44	-0.42	-0.43	-0.40	-0.19	0.02	0.01	
2016	0.13	-0.22	-24.12	0.35	0.29	0.10	-0.59	-0.52	-0.60	-0.53	-0.33	0.01	0.01	
2017	0.13	-0.21	-22.88	0.34	0.29	0.10	-0.69	-0.58	-0.71	-0.63	-0.43	0.00	0.01	
2018	0.13	-0.19	-21.95	0.33	0.30	0.10	-0.76	-0.62	-0.79	-0.69	-0.49	-0.01	0.00	
2019	0.13	-0.19	-21.24	0.32	0.29	0.10	-0.81	-0.65	-0.83	-0.73	-0.54	-0.01	0.00	
2020	0.13	-0.18	-20.69	0.31	0.29	0.10	-0.84	-0.67	-0.87	-0.76	-0.57	-0.01	0.00	

Table HSL4M: Slovenia - medium value externality elasticities

Date	GDPM (g)	L (g)	GECSFRAE (l)	GECSFRAP (l)	KGINFR	KTRNR	GDPM	L	L (d)	LPROD	OT	LT	LT	LPRT
2006			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	2.61	0.23	2.15	3.58	3.30	1.25	5.05	4.98	45.22	0.34	3.77	3.61	8.52	0.16
2008	2.66	0.27	2.07	3.45	6.32	2.39	5.18	4.88	44.47	0.56	4.33	3.90	9.11	0.42
2009	2.72	0.30	1.99	3.32	9.09	3.43	5.44	4.78	43.63	0.93	5.24	4.39	10.16	0.81
2010	2.78	0.34	1.92	3.20	11.65	4.38	5.85	4.66	42.75	1.45	6.47	5.07	11.61	1.33
2011	2.85	0.38	1.85	3.08	14.01	5.24	6.39	4.55	41.86	2.10	8.00	5.93	13.43	1.95
2012	2.91	0.42	1.79	2.98	16.20	6.03	6.61	4.43	40.98	2.43	8.66	6.30	14.14	2.23
2013	2.97	0.46	1.72	2.87	18.22	6.74	6.82	4.33	40.18	2.74	9.27	6.63	14.75	2.48
2014	3.04	0.50	0.00	0.00	17.46	6.38	2.30	-0.15	-1.43	2.61	5.73	3.35	7.38	2.31
2015	3.10	0.54	0.00	0.00	16.74	6.03	2.25	-0.17	-1.59	2.56	5.50	3.22	7.05	2.21
2016	3.17	0.58	0.00	0.00	16.07	5.70	2.21	-0.17	-1.60	2.52	5.30	3.11	6.75	2.12
2017	3.23	0.62	0.00	0.00	15.44	5.39	2.17	-0.17	-1.59	2.47	5.10	3.01	6.47	2.03
2018	3.30	0.67	0.00	0.00	14.84	5.10	2.14	-0.16	-1.57	2.43	4.91	2.91	6.21	1.95
2019	3.37	0.71	0.00	0.00	14.27	4.82	2.11	-0.16	-1.54	2.39	4.73	2.81	5.97	1.87
2020	3.44	0.75	0.00	0.00	13.74	4.56	2.08	-0.15	-1.50	2.35	4.57	2.72	5.74	1.79
Date	ON	LLN	LLN (d)	LPRN	CONS	I	PGDPFC	POT	PON	PCONS	WT	NTSVR	GBORR	
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
2007	8.08	7.63	35.09	0.41	4.11	19.90	0.12	-0.01	-0.16	0.09	0.13	-2.09	-0.61	
2008	7.95	7.26	33.79	0.65	4.17	19.40	-0.15	-0.12	-0.50	-0.12	0.00	-1.91	-0.70	
2009	7.84	6.77	31.94	1.01	4.32	18.85	-0.56	-0.30	-0.99	-0.42	-0.20	-1.75	-0.71	
2010	7.77	6.19	29.65	1.48	4.55	18.30	-1.16	-0.54	-1.69	-0.87	-0.50	-1.59	-0.72	
2011	7.73	5.56	26.97	2.06	4.86	17.72	-1.92	-0.85	-2.60	-1.45	-0.91	-1.44	-0.74	
2012	7.59	5.16	25.42	2.30	4.93	17.16	-2.56	-1.05	-3.42	-1.92	-1.31	-1.34	-0.72	
2013	7.46	4.81	24.05	2.53	5.04	16.61	-3.04	-1.21	-4.00	-2.29	-1.61	-1.22	-0.70	
2014	0.37	-1.74	-8.82	2.15	1.23	-0.64	-3.45	-1.27	-4.23	-2.60	-1.97	0.56	-0.21	
2015	0.34	-1.68	-8.64	2.05	1.20	-0.70	-3.42	-1.25	-4.17	-2.58	-1.97	0.50	-0.10	
2016	0.34	-1.60	-8.35	1.97	1.19	-0.70	-3.36	-1.21	-4.07	-2.53	-1.95	0.46	-0.10	
2017	0.34	-1.52	-8.06	1.89	1.18	-0.69	-3.29	-1.18	-3.96	-2.48	-1.93	0.43	-0.09	
2018	0.34	-1.44	-7.78	1.81	1.18	-0.68	-3.23	-1.15	-3.85	-2.43	-1.90	0.41	-0.09	
2019	0.35	-1.37	-7.51	1.74	1.17	-0.66	-3.16	-1.11	-3.74	-2.38	-1.87	0.39	-0.09	
2020	0.35	-1.29	-7.23	1.67	1.17	-0.65	-3.09	-1.08	-3.63	-2.32	-1.83	0.38	-0.08	

[6] Convergence and cohesion: sensitivity analysis

6.1 Introductory remarks

The key objective of the *CP/CF* interventions is to boost the supply-side capacity of the beneficiary economies. Earlier in sections 3 and 4 we described how we attempt to model this process by incorporating output and factor productivity externalities into the system of model equations. These externality mechanisms serve to link the *CP/CF* interventions directly with the supply-side performance of the economy.

If we could base our choice of externality elasticities firmly on local research, then we could propose specific elasticity values that were appropriate to the conditions in each specific country, and which could be incorporated into specific models. Unfortunately we do not have access to such research findings for the new member states. Indeed, in all of our previous research carried out on evaluation of Structural Funds, we have been unable to access any research of a microeconomic nature that would help guide us in our selection of infrastructural and human capital elasticities for these countries. Consequently, we are forced to fall back on the international literature, and make use of findings in a range of countries that have similarities with the beneficiary economies. We reviewed this literature earlier (see appendix to Section 4), and concentrated on the "old" EU cohesion countries and Italy which are more like the new member states than countries like the United States, Germany or France. This review shows that the elasticities used by us are broadly within the range found for those countries.

The international empirical literature, although vast, continues to be somewhat ambiguous about the appropriate magnitude of the externalities, especially for those on the role of human capital. Different researchers use different methodologies, and arrive at different conclusions.[48] Faced with this situation, there are two possible strategies. The first would be to wait until the research results are available in the new member states, and to stand aside from any attempt to quantify the likely macroeconomic impacts of the *CP/CF* interventions. The second would be to carry out the macroeconomic evaluation exercises with a range of externality elasticities, that are in a plausible range, and to exercise judgement on the most appropriate values for each country based on a wide range of information about the situation in each country.

For example, in the case of the earlier Irish CSFs, there is a body of evidence that suggests that the ESF training schemes – as implemented by the Irish State Training Agency (FÁS), were reasonably well targeted, closely integrated with other economic development policies, and were reasonably effective (Honohan (ed.), 1997; Denny, Harmon and O'Connell (2000)). This might suggest that externality elasticities near the top of the international range might be appropriate in this case. In the case of the Italian *Mezzogiorno* and the Greek CSFs of the 1990s, the limited information that we have on the extensive re-phasing (or "re-programming") of CSF 94-99 that was carried out, suggests that difficulties may have arisen at the design and implementation stages of many of the Italian and Greek Operational Programmes.

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

This might imply that lower values for the externality elasticities should be used.[49] In both extreme cases, a sensitivity analysis needs to be carried out to explore how the CSF impact changes as the two types of externalities – with respect to physical infrastructure and with respect to human capital - are varied from low to high values. For this exercise, the numbers shown in table 6.1 have been used.

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

		Factor productivity elasticities		
		0.00	**0.10**	**0.20**
Output elasticities	**0.00**	Zero – Zero		
	0.20		Medium – Medium	
	0.40			High - High

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

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

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

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

6.2 Sensitivity analysis

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

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

In the case of the "high-high" combination, the longer-run supply-side effects become much more relevant, particularly over time as the stocks of physical infrastructure and human capital build up. Compared to the findings taken from the empirical literature, our high elasticities sometimes fall into the middle of the observed scale, but we deliberately adopted a conservative definition of "high" externality elasticities.

In the "high–high" case, we get the demand-side impacts while the *CP/CF* interventions are being implemented, and this is accompanied by a gradual build up of supply-side impacts that continue even after the programme is terminated. Eventually depreciation effects set in and the economy will start converging back towards the original no-intervention baseline level of activity. But this is a long drawn out process, and will continue long after the terminal year of our simulations, namely the year 2020.

We have already presented the simulation results for the "medium-medium" case in the Section 5. The following set of tables present the simulation results for the remaining two stylised *CP/CF* intervention scenarios, namely a "zero-zero" choice of externality elasticities for physical infrastructure and human capital; and a "high-high" option, where the elasticities are assumed to take the values 0.40 (for output) and 0.2 (for factor productivity), i.e., values that are sometimes towards the upper range of results found in the international literature.

Once again, there is a large amount of information contained in these two appendices. In Table 6.2 we illustrate the issue of sensitive analysis using the Czech Republic as an example. Note that the results presented in Table 6.2 are simply the percentage increases in GDP that arise as a result of the CSF shock. They should not be confused with either "normal" multipliers or with "cumulative" multipliers. Note also that exactly the same CSF expenditure shock is administered in each case. The expenditure is abruptly terminated in all three cases after the year 2013. All that differs between the "zero-zero", "medium-medium" and "high-high" simulations are the sizes assumed for the externality elasticities.

Table 6.2: The Czech Republic: zero, medium and high elasticities: impacts on GDP (GDPM) and total employment (L)

	ZERO-ZERO		MEDIUM-MEDIUM		HIGH-HIGH	
	GDPM	L	GDPM	L	GDPM	L
	% dev from base	% dev from base	% dev from base	% dev from base	% dev from base	% dev from base
2006	0	0	0	0	0	0
2007	4.8	5.1	4.9	5.1	5.0	5.1
2008	6.2	6.3	6.6	6.3	7.0	6.4
2010	6.6	6.8	8.5	7.2	10.4	7.7
2013	6.2	7.0	10.9	8.3	15.8	9.6
2014	2.0	2.0	6.8	3.6	12.0	5.4
2020	0.2	0.3	4.4	1.7	8.9	3.1

The case of the Czech Republic is illustrative of the type of rapid transitional growth that can occur if the structure of the economy is oriented towards competitive growth and active participation in the Single European Market (see ESRI, 1997 for background to this point). The "zero-zero" impacts are the multiplier impacts that tend to accompany investment shocks that are directed mainly at construction and training schemes, i.e., shocks that have rather low leakages out of the economy. But after the termination of the programmes in 2013, the benefits decline quickly to almost zero by 2020.

Moving from "zero-zero" to "medium-medium" and eventually to "high-high" combinations produces very significant and increasingly large boosts to GDP. Also, since the higher "stocks" of infrastructure and human capital continue to generate benefits after the programmes cease in 2013, the higher level of GDP is sustained, at 4.4 per cent for the "medium-medium" case, and 8.9 per cent in the "high-high" case. However, high elasticities also imply high productivity growth. For the "medium-medium" case, growth in the level employment is about half of the sustained growth in the level of GDP by 2020. In the "high-high" scenario, growth in the level of employment is only about one-third of the growth in the level of GDP.

A broadly similar pattern is repeated in the other models, and the detailed results for all models for the "zero-zero" and "high-high" cases are presented in Appendices S6.1 and S6.2 below.. The higher the assumed externality elasticities, the higher will be the sustained increase in the *level* of GDP and employment after the programmes terminate. But at the present state of knowledge, we cannot yet predict with any degree of confidence whether the elasticities will be high or low for any given new member state. In the case of the "old" member states, at least we have over 15 years experience to draw upon, spread over three separate National Development Plans. But even then, we cannot be sure whether slow convergence is due to poor design and implementation of the NDP (i.e., low externality elasticities), or other non-CSF related matters (internal fiscal pressures, asymmetric shocks, etc.).

But what this analysis suggests is that there is a close relationship between the size of the externality elasticities and the success of cohesion. We suggest that any well-design and efficiently implemented NDP will be associated with high externality elasticities, and the international literature tends to confirm that connection.

6.3 Conclusions

It would be possible to extend Table 6.1 and the tables of Appendices S6.1 and S6.2 to include asymmetric options (e.g., of the "high-low" variety). But we have little indication from the literature that such options are relevant. But a much more important issue concerns the optimum balance between investment in physical infrastructure and human resources. This deserves detailed investigation, but we have been unable to find anything of substance in the international literature. It should be stressed that we implement the externality mechanisms for physical infrastructure and human capital in HERMIN as two separate and unrelated processes. In theory, we could set the level of either of these two investment expenditures at any values (including zero), and examine the impact of the "reconfigured" *CP/*CF programmes on the economy. But there are a number of objections to this approach.

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

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

Consequently, we feel that it would be misleading to present HERMIN-based simulation results where the funding allocations as between physical infrastructure, human resources and direct aid to the productive sectors were varied. In addition to criticisms based on the analysis of the “standard” *CP/CF* programme allocations, there would be a wide range of other criticisms that would invalidate any policy conclusions reached on the basis of such crude simulations.

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

Appendix S6.1 Simulation results using “zero” externality elasticities

Table HC4Z: The Czech Republic - zero externality elasticities

Date	GDPM	L	L (d)	LPROD	OT	LT	LPRT	ON	LLN	LPRN	CONS	I	NTSVR (d)	GBORR (d)
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	4.82	5.10	249	0.12	1.48	1.42	0.06	9.31	9.55	-0.21	2.02	20.02	-2.87	4.33
2008	6.18	6.26	305	-0.07	1.01	0.95	0.06	12.09	12.37	-0.26	6.70	21.95	-4.09	3.44
2009	6.55	6.70	327	-0.23	0.93	0.86	0.07	13.09	13.39	-0.27	7.90	22.86	-4.36	3.03
2010	6.56	6.84	334	-0.40	0.88	0.81	0.07	13.43	13.74	-0.27	8.29	23.21	-4.50	2.95
2011	6.47	6.90	337	-0.56	0.86	0.79	0.07	13.58	13.89	-0.28	8.42	23.42	-4.58	2.99
2012	6.35	6.95	340	-0.73	0.84	0.78	0.07	13.68	14.00	-0.28	8.47	23.63	-4.66	3.08
2013	6.23	6.99	343	-0.90	0.83	0.76	0.06	13.77	14.09	-0.28	8.51	23.81	-4.73	3.17
2014	2.01	1.97	97.11	-0.49	-0.46	-0.47	0.01	4.51	4.60	-0.09	6.71	3.20	-1.94	-0.76
2015	0.82	0.83	41.00	-0.18	-0.05	-0.06	0.01	1.80	1.83	-0.03	2.35	1.37	-0.61	0.03
2016	0.41	0.42	20.94	-0.10	0.01	0.01	0.00	0.89	0.91	-0.02	1.21	0.63	-0.32	0.48
2017	0.30	0.31	15.38	-0.07	0.04	0.04	0.00	0.62	0.64	-0.01	0.84	0.45	-0.22	0.63
2018	0.27	0.28	14.00	-0.07	0.05	0.05	0.00	0.56	0.57	-0.01	0.75	0.39	-0.19	0.66
2019	0.26	0.28	13.92	-0.07	0.05	0.05	0.00	0.55	0.56	-0.01	0.73	0.39	-0.19	0.65
2020	0.25	0.28	14.20	-0.08	0.05	0.05	0.00	0.55	0.57	-0.01	0.74	0.39	-0.19	0.63

Table HE4Z: Estonia - zero externality elasticities

Date	GDPM	L	L(d)	LPROD	OT	LT	LPRT	ON	LLN	LPRN	CONS	I	NTSVR (d)	GBORR (d)
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	6.35	5.18	29.67	1.02	5.38	5.43	-0.04	7.47	7.41	0.05	6.96	23.49	-4.13	0.63
2008	6.83	5.42	31.08	1.15	5.60	5.56	0.03	8.06	7.85	0.19	8.02	24.62	-4.00	0.38
2009	6.94	5.49	31.53	1.18	5.70	5.65	0.05	8.20	7.94	0.24	8.28	24.76	-3.61	0.32
2010	6.80	5.40	31.13	1.14	5.58	5.53	0.05	8.06	7.81	0.23	8.04	24.30	-3.52	0.36
2011	6.62	5.30	30.64	1.10	5.44	5.39	0.05	7.89	7.65	0.23	7.74	23.78	-3.45	0.43
2012	6.44	5.18	30.14	1.05	5.29	5.24	0.05	7.70	7.47	0.22	7.43	23.19	-3.38	0.50
2013	6.24	5.05	29.56	1.01	5.13	5.07	0.05	7.49	7.26	0.22	7.10	22.49	-3.29	0.57
2014	0.11	0.00	0.01	0.13	-0.11	-0.19	0.08	0.27	0.11	0.17	-0.01	1.19	0.54	-0.06
2015	-0.52	-0.36	-2.16	-0.04	-0.46	-0.48	0.02	-0.46	-0.49	0.03	-1.33	-0.13	0.61	0.20
2016	-0.75	-0.50	-3.04	-0.09	-0.66	-0.65	0.00	-0.70	-0.68	-0.03	-1.76	-0.57	0.34	0.29
2017	-0.70	-0.47	-2.89	-0.08	-0.61	-0.60	0.00	-0.66	-0.64	-0.02	-1.68	-0.51	0.28	0.29
2018	-0.64	-0.43	-2.68	-0.08	-0.55	-0.55	0.00	-0.60	-0.58	-0.02	-1.54	-0.46	0.24	0.26
2019	-0.58	-0.39	-2.45	-0.07	-0.49	-0.49	0.00	-0.54	-0.52	-0.02	-1.39	-0.40	0.21	0.23
2020	-0.52	-0.35	-2.23	-0.06	-0.44	-0.44	0.00	-0.48	-0.46	-0.02	-1.25	-0.35	0.19	0.21

Table HG4Z: Greece - zero externality elasticities

Date	GDPM	L	L (d)	LPROD	OT	LT	LPRT	ON	LLN	LPRN	CONS	I	NTSVR (d)	GBORR (d)
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	1.73	1.58	63.03	0.23	2.32	2.67	-0.34	2.00	2.11	-0.11	1.27	9.42	-1.54	0.62
2008	1.54	1.41	56.51	0.23	1.80	2.05	-0.25	1.86	1.95	-0.09	1.33	8.69	-1.31	0.62
2009	1.31	1.23	49.28	0.21	1.41	1.61	-0.20	1.65	1.73	-0.07	1.13	7.85	-0.96	0.57
2010	1.15	1.09	43.99	0.18	1.18	1.35	-0.17	1.47	1.54	-0.07	0.97	7.09	-0.77	0.56
2011	1.06	1.01	40.87	0.16	1.09	1.25	-0.16	1.36	1.42	-0.06	0.95	6.46	-0.69	0.53
2012	1.00	0.95	38.54	0.15	1.03	1.19	-0.16	1.26	1.32	-0.06	0.98	5.90	-0.64	0.50
2013	0.95	0.89	36.44	0.13	0.99	1.14	-0.15	1.18	1.23	-0.05	1.01	5.38	-0.60	0.47
2014	-0.01	0.00	0.20	0.01	-0.26	-0.31	0.05	0.07	0.07	0.00	0.30	0.03	0.22	0.11
2015	0.03	0.03	1.24	0.01	-0.04	-0.05	0.01	0.06	0.06	0.00	0.24	-0.01	0.14	0.07
2016	0.09	0.07	2.93	0.00	0.11	0.13	-0.02	0.09	0.09	-0.01	0.33	0.02	0.00	0.07
2017	0.14	0.10	4.33	0.01	0.20	0.24	-0.04	0.12	0.13	-0.01	0.41	0.09	-0.07	0.05
2018	0.15	0.11	4.72	0.01	0.22	0.26	-0.04	0.13	0.14	-0.01	0.43	0.11	-0.09	0.04
2019	0.15	0.11	4.70	0.01	0.22	0.26	-0.04	0.13	0.13	-0.01	0.42	0.12	-0.09	0.04
2020	0.14	0.11	4.55	0.01	0.20	0.24	-0.04	0.12	0.13	0.00	0.40	0.12	-0.08	0.03

Table HGE4Z: East Germany - zero externality elasticities

Date	GDPM	L	L(d)	LPROD	OT	LT	LPRT	ON	LLN	LPRN	CONS	I	NTSVR (d)	GBORR (d)
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	0.99	0.98	69.53	0.01	0.71	0.68	0.03	0.81	0.80	0.01	0.94	2.39	-0.54	0.15
2008	1.02	1.01	71.20	0.00	0.73	0.70	0.03	0.85	0.84	0.01	1.00	2.42	-0.56	0.15
2009	1.00	1.00	69.82	0.00	0.72	0.69	0.03	0.84	0.83	0.01	0.99	2.38	-0.55	0.15
2010	0.98	0.99	68.46	-0.01	0.71	0.68	0.03	0.83	0.82	0.01	0.98	2.34	-0.54	0.15
2011	0.96	0.97	67.06	-0.01	0.70	0.67	0.03	0.82	0.81	0.01	0.97	2.29	-0.53	0.14
2012	0.94	0.96	65.64	-0.01	0.69	0.66	0.03	0.81	0.80	0.01	0.97	2.25	-0.52	0.14
2013	0.92	0.94	64.18	-0.02	0.68	0.65	0.03	0.80	0.79	0.01	0.95	2.20	-0.51	0.14
2014	0.03	0.02	1.58	0.00	0.02	0.02	0.00	0.03	0.03	0.00	0.05	0.02	-0.01	0.00
2015	0.01	0.01	0.53	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.02	0.01	0.00	0.00
2016	0.01	0.01	0.57	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.02	0.01	0.00	0.00
2017	0.01	0.01	0.55	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.02	0.01	0.00	0.00
2018	0.01	0.01	0.53	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.02	0.01	0.00	0.00
2019	0.01	0.01	0.52	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.02	0.01	0.00	0.00
2020	0.01	0.01	0.50	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.02	0.01	0.00	0.00

Table HH4Z: Hungary - zero externality elasticities

Date	GDPM	L	L(d)	LPROD	OT	LT	LPRT	ON	LLN	LPRN	CONS	I	NTSVR (d)	GBORR (d)
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	3.87	3.81	139	0.24	0.87	0.79	0.07	7.89	7.76	0.12	2.59	30.92	-3.89	1.06
2008	3.79	3.73	135	0.16	0.39	0.21	0.18	8.17	7.91	0.25	3.06	32.97	-3.48	0.50
2009	4.01	4.03	145	0.08	0.47	0.25	0.22	8.86	8.54	0.29	3.32	35.04	-3.36	0.38
2010	4.13	4.24	151	-0.04	0.50	0.27	0.22	9.31	8.98	0.30	3.64	36.74	-3.58	0.31
2011	4.23	4.45	158	-0.17	0.53	0.29	0.23	9.77	9.43	0.31	3.86	38.60	-3.76	0.33
2012	4.23	4.57	161	-0.30	0.54	0.30	0.24	10.03	9.68	0.32	4.03	39.63	-3.86	0.32
2013	4.22	4.69	164	-0.44	0.56	0.32	0.24	10.28	9.93	0.33	4.18	40.64	-3.96	0.32
2014	0.00	-0.04	-1.40	-0.06	-0.54	-0.70	0.16	0.50	0.31	0.19	0.82	1.84	0.49	-0.89
2015	0.14	0.13	4.59	0.00	0.04	0.00	0.04	0.36	0.30	0.05	0.17	0.65	0.23	-0.27
2016	0.02	0.01	0.46	-0.01	-0.01	0.00	0.00	0.03	0.03	0.00	0.11	-0.01	-0.01	-0.10
2017	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.02	0.01	-0.01
2018	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2019	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table HL4Z: Latvia - zero externality elasticities

Date	GDPM	L	L(d)	LPROD	OT	LT	LPRT	ON	LLN	LPRN	CONS	I	NTSVR (d)	GBORR (d)
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	8.62	6.53	63.90	2.09	4.00	4.02	-0.02	11.23	11.77	-0.48	8.86	27.93	-3.87	0.03
2008	8.79	6.68	65.73	2.10	4.07	4.10	-0.02	11.42	11.95	-0.48	8.97	28.34	-3.87	-0.36
2009	8.94	6.83	67.52	2.11	4.14	4.16	-0.02	11.58	12.12	-0.48	9.06	28.68	-3.90	-0.28
2010	9.07	6.96	69.26	2.10	4.19	4.22	-0.02	11.72	12.25	-0.48	9.12	28.95	-3.93	-0.18
2011	9.19	7.09	70.96	2.10	4.24	4.27	-0.03	11.83	12.37	-0.48	9.18	29.14	-3.95	-0.09
2012	9.33	7.24	72.95	2.09	4.30	4.33	-0.03	11.98	12.52	-0.48	9.27	29.39	-3.99	0.00
2013	9.44	7.36	74.73	2.08	4.34	4.37	-0.03	12.08	12.61	-0.47	9.33	29.48	-4.01	0.09
2014	-0.88	-0.62	-6.30	-0.17	-0.44	-0.45	0.00	-1.02	-1.06	0.04	-2.12	-0.66	0.48	0.09
2015	-0.83	-0.58	-6.02	-0.16	-0.42	-0.42	0.00	-0.95	-1.00	0.04	-2.01	-0.58	0.43	0.66
2016	-0.79	-0.56	-5.82	-0.15	-0.40	-0.40	0.00	-0.91	-0.95	0.04	-1.91	-0.55	0.40	0.62
2017	-0.75	-0.53	-5.61	-0.14	-0.38	-0.38	0.00	-0.86	-0.89	0.04	-1.82	-0.52	0.37	0.57
2018	-0.71	-0.51	-5.41	-0.13	-0.35	-0.36	0.00	-0.81	-0.84	0.03	-1.72	-0.48	0.35	0.53
2019	-0.67	-0.48	-5.20	-0.12	-0.33	-0.34	0.00	-0.76	-0.79	0.03	-1.63	-0.45	0.32	0.49
2020	-0.63	-0.46	-5.00	-0.11	-0.31	-0.32	0.00	-0.71	-0.74	0.03	-1.54	-0.41	0.30	0.45

Table HMZ4: The Italian *Mezzogiorno* - zero externality elasticities

Date	GDPM	L	L(d)	LPROD	OT	LT	LPRT	ON	LLN	LPRN	CONS	I	NTSVR (d)	GBORR (d)
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	1.93	1.72	115	0.20	1.43	1.32	0.11	2.68	2.61	0.06	1.37	12.09	-1.37	-0.89
2008	1.63	1.43	95.95	0.19	0.39	0.31	0.07	2.44	2.33	0.11	1.23	11.99	-1.53	-1.05
2009	1.50	1.31	88.02	0.19	0.00	-0.06	0.06	2.32	2.19	0.13	0.99	11.86	-1.30	-1.05
2010	1.41	1.23	83.09	0.18	-0.13	-0.18	0.05	2.21	2.08	0.13	0.83	11.62	-1.18	-1.07
2011	1.38	1.21	81.85	0.17	-0.14	-0.19	0.05	2.16	2.03	0.12	0.80	11.43	-1.14	-1.06
2012	1.37	1.20	81.51	0.17	-0.13	-0.18	0.05	2.13	2.00	0.12	0.80	11.27	-1.12	-1.04
2013	1.36	1.20	81.37	0.16	-0.11	-0.16	0.05	2.10	1.98	0.12	0.82	11.12	-1.11	-1.02
2014	-0.39	-0.37	-25.10	-0.02	-1.35	-1.31	-0.04	-0.26	-0.32	0.06	-0.39	0.17	0.06	-0.18
2015	-0.12	-0.11	-7.78	-0.01	-0.44	-0.43	-0.01	-0.07	-0.09	0.02	-0.24	0.06	0.23	-0.02
2016	-0.01	0.00	-0.30	0.00	-0.11	-0.10	0.00	0.02	0.02	0.00	0.01	0.01	0.04	0.03
2017	0.07	0.06	4.46	0.00	0.01	0.01	0.00	0.11	0.11	0.00	0.18	0.09	-0.05	0.08
2018	0.08	0.08	5.35	0.01	0.01	0.01	0.00	0.13	0.13	0.01	0.23	0.12	-0.08	0.08
2019	0.08	0.08	5.35	0.01	0.01	0.00	0.00	0.14	0.13	0.01	0.23	0.13	-0.08	0.08
2020	0.08	0.07	5.23	0.01	0.00	0.00	0.00	0.13	0.13	0.01	0.22	0.13	-0.08	0.08

Table HP4Z: Portugal - zero externality elasticities

Date	GDPM	L	L(d)	LPROD	OT	LT	LPRT	ON	LLN	LPRN	CONS	I	NTSVR (d)	GBORR (d)
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	1.99	1.63	79.62	0.50	1.34	1.44	-0.10	2.77	2.73	0.03	1.42	6.85	-1.20	0.52
2008	1.76	1.44	69.90	0.48	0.80	0.83	-0.03	2.64	2.59	0.05	1.43	6.58	-0.87	0.53
2009	1.52	1.29	62.58	0.44	0.67	0.69	-0.02	2.38	2.34	0.04	0.98	6.31	-0.43	0.44
2010	1.52	1.28	62.09	0.43	0.72	0.75	-0.03	2.35	2.31	0.04	1.05	6.20	-0.48	0.51
2011	1.63	1.33	64.66	0.44	0.83	0.87	-0.04	2.42	2.38	0.04	1.40	6.17	-0.57	0.52
2012	1.69	1.36	65.80	0.45	0.88	0.93	-0.04	2.46	2.42	0.04	1.66	6.11	-0.60	0.53
2013	1.73	1.37	66.31	0.45	0.93	0.97	-0.05	2.48	2.44	0.04	1.84	6.04	-0.60	0.54
2014	0.27	0.14	7.01	0.06	-0.03	-0.05	0.02	0.36	0.35	0.02	1.02	0.17	0.28	0.10
2015	0.52	0.32	15.50	0.09	0.45	0.48	-0.03	0.49	0.48	0.01	1.28	0.27	0.01	0.06
2016	0.80	0.47	22.95	0.13	0.63	0.67	-0.04	0.74	0.73	0.01	1.89	0.45	-0.36	0.11
2017	0.83	0.49	23.74	0.14	0.63	0.67	-0.04	0.79	0.78	0.01	1.99	0.49	-0.32	0.07
2018	0.76	0.45	21.77	0.14	0.56	0.60	-0.03	0.73	0.72	0.01	1.84	0.46	-0.25	0.07
2019	0.75	0.44	21.32	0.13	0.56	0.59	-0.04	0.72	0.71	0.01	1.78	0.45	-0.24	0.07
2020	0.75	0.45	21.45	0.14	0.56	0.60	-0.04	0.73	0.71	0.01	1.78	0.46	-0.25	0.06

Table HPO4Z: Poland - zero externality elasticities

Date	GDPM	L	L (d)	LPROD	OT	LT	LPRT	ON	LLN	LPRN	CONS	I	NTSVR (d)	GBORR (d)
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	6.66	4.91	657	1.51	5.57	5.50	0.07	8.53	8.58	-0.05	7.66	31.52	-3.00	-0.59
2008	6.92	4.95	663	1.55	4.93	4.74	0.17	9.06	9.03	0.03	9.06	31.94	-2.53	-1.16
2009	6.89	4.90	659	1.56	4.93	4.70	0.22	9.04	8.98	0.06	9.01	32.03	-2.50	-1.27
2010	6.76	4.81	647	1.53	4.82	4.60	0.22	8.89	8.83	0.06	8.85	31.43	-2.41	-1.26
2011	6.61	4.71	635	1.49	4.71	4.49	0.21	8.72	8.66	0.06	8.65	30.73	-2.33	-1.24
2012	6.46	4.61	623	1.46	4.60	4.39	0.21	8.55	8.49	0.05	8.46	30.02	-2.24	-1.22
2013	6.31	4.50	611	1.42	4.49	4.28	0.20	8.37	8.32	0.05	8.27	29.26	-2.16	-1.20
2014	0.35	0.15	20.76	0.07	-0.43	-0.57	0.14	0.67	0.58	0.09	1.12	1.65	0.30	-0.84
2015	-0.17	-0.11	-14.91	-0.01	-0.14	-0.18	0.04	-0.15	-0.18	0.03	-0.45	0.31	0.09	-0.35
2016	-0.27	-0.16	-21.92	-0.05	-0.21	-0.21	0.00	-0.29	-0.29	0.00	-0.61	-0.23	0.11	-0.22
2017	-0.27	-0.16	-22.13	-0.05	-0.21	-0.20	-0.01	-0.29	-0.29	0.00	-0.62	-0.26	0.11	-0.20
2018	-0.27	-0.16	-21.59	-0.05	-0.20	-0.19	-0.01	-0.29	-0.29	0.00	-0.61	-0.25	0.10	-0.19
2019	-0.26	-0.15	-20.94	-0.05	-0.19	-0.19	-0.01	-0.28	-0.28	0.00	-0.59	-0.24	0.10	-0.19
2020	-0.25	-0.15	-20.28	-0.05	-0.19	-0.18	-0.01	-0.27	-0.27	0.00	-0.57	-0.23	0.09	-0.18

Table HR4Z: Romania - zero externality elasticities

Date	GDPM	L	L (d)	LPROD	OT	LT	LPRT	ON	LLN	LPRN	CONS	I	NTSVR (d)	GBORR (d)
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	4.72	2.56	226	2.40	2.35	2.22	0.13	6.73	6.80	-0.07	2.19	26.38	-2.54	1.56
2008	6.07	3.31	296	3.04	2.96	2.80	0.16	8.61	8.70	-0.09	2.46	34.26	-2.80	1.83
2009	7.73	4.25	384	3.79	3.74	3.54	0.20	10.88	11.00	-0.11	3.20	42.82	-3.31	2.27
2010	7.98	4.42	404	3.86	3.83	3.62	0.20	11.16	11.28	-0.11	3.21	43.58	-3.11	2.27
2011	8.31	4.64	429	3.96	3.97	3.76	0.21	11.54	11.67	-0.11	3.38	44.42	-3.06	2.32
2012	8.66	4.87	456	4.06	4.12	3.89	0.22	11.93	12.06	-0.11	3.55	45.28	-3.05	2.35
2013	9.01	5.11	485	4.16	4.27	4.03	0.22	12.34	12.46	-0.11	3.74	46.15	-3.06	2.39
2014	-0.71	-0.39	-37.59	-0.32	-0.46	-0.43	-0.03	-0.92	-0.92	0.00	-1.37	-1.10	1.37	-0.07
2015	-0.07	-0.04	-3.92	-0.03	-0.05	-0.04	0.00	-0.09	-0.09	0.00	-0.14	-0.10	0.35	0.36
2016	-0.17	-0.09	-9.36	-0.07	-0.11	-0.10	-0.01	-0.21	-0.22	0.00	-0.33	-0.24	0.17	0.27
2017	-0.15	-0.09	-8.83	-0.07	-0.10	-0.09	-0.01	-0.20	-0.20	0.00	-0.30	-0.22	0.05	0.27
2018	-0.15	-0.09	-9.04	-0.07	-0.10	-0.09	-0.01	-0.19	-0.20	0.00	-0.30	-0.22	0.00	0.25
2019	-0.15	-0.09	-9.15	-0.06	-0.10	-0.09	-0.01	-0.19	-0.19	0.00	-0.29	-0.22	-0.01	0.24
2020	-0.15	-0.09	-9.27	-0.06	-0.09	-0.09	-0.01	-0.19	-0.19	0.00	-0.29	-0.21	-0.02	0.23

Table HS4Z: Spain - zero externality elasticities

Date	GDPM	L	L(d)	LPROD	OT	LT	LPRT	ON	LLN	LPRN	CONS	I	NTSVR (d)	GBORR (d)
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	0.64	0.54	90.11	0.10	0.60	0.58	0.03	0.72	0.70	0.02	0.55	2.39	-0.46	0.14
2008	0.62	0.53	88.13	0.10	0.56	0.53	0.03	0.71	0.68	0.02	0.56	2.30	-0.44	0.13
2009	0.59	0.50	84.45	0.10	0.51	0.49	0.03	0.67	0.65	0.02	0.55	2.17	-0.41	0.12
2010	0.56	0.47	80.68	0.09	0.47	0.45	0.02	0.64	0.62	0.02	0.53	2.04	-0.38	0.12
2011	0.53	0.45	77.41	0.08	0.44	0.42	0.02	0.61	0.59	0.02	0.51	1.91	-0.35	0.11
2012	0.50	0.43	74.55	0.08	0.41	0.39	0.02	0.58	0.56	0.02	0.49	1.80	-0.33	0.11
2013	0.48	0.41	71.94	0.07	0.38	0.36	0.02	0.56	0.54	0.02	0.48	1.70	-0.31	0.10
2014	0.03	0.02	3.09	0.01	-0.03	-0.03	0.00	0.05	0.04	0.00	0.10	0.05	0.00	-0.01
2015	0.03	0.02	3.19	0.01	-0.02	-0.02	0.00	0.04	0.04	0.00	0.09	0.03	0.01	-0.01
2016	0.03	0.02	3.83	0.00	0.00	0.00	0.00	0.04	0.04	0.00	0.09	0.03	0.00	-0.01
2017	0.03	0.03	4.69	0.00	0.01	0.01	0.00	0.04	0.04	0.00	0.09	0.03	-0.01	-0.01
2018	0.04	0.03	5.23	0.00	0.02	0.02	0.00	0.04	0.04	0.00	0.10	0.03	-0.01	-0.01
2019	0.04	0.03	5.54	0.00	0.02	0.02	0.00	0.04	0.04	0.00	0.10	0.04	-0.02	-0.01
2020	0.04	0.03	5.69	0.00	0.02	0.02	0.00	0.04	0.04	0.00	0.09	0.04	-0.02	-0.01

Table HSL4Z: Slovenia - Zero externality elasticities														
Date	GDPM	L	L (d)	LPROD	OT	LT	LPRT	ON	LLN	LPRN	CONS	I	NTSVR (d)	GBORR (d)
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	4.97	4.98	45.26	0.26	3.55	3.48	0.07	8.06	7.71	0.33	4.05	19.91	-2.10	-0.60
2008	4.86	4.90	44.61	0.23	3.48	3.41	0.07	7.87	7.53	0.32	3.97	19.44	-1.95	-0.68
2009	4.76	4.81	43.96	0.20	3.41	3.34	0.07	7.68	7.36	0.30	3.90	18.94	-1.83	-0.65
2010	4.65	4.73	43.35	0.17	3.33	3.26	0.07	7.50	7.19	0.29	3.84	18.48	-1.72	-0.64
2011	4.56	4.65	42.77	0.14	3.26	3.19	0.07	7.33	7.03	0.28	3.78	18.02	-1.64	-0.62
2012	4.46	4.57	42.21	0.11	3.19	3.12	0.07	7.16	6.87	0.27	3.72	17.58	-1.56	-0.60
2013	4.36	4.49	41.68	0.08	3.12	3.05	0.07	6.99	6.71	0.26	3.66	17.14	-1.49	-0.58
2014	0.00	0.00	0.02	0.00	0.01	0.00	0.00	0.00	0.00	0.00	-0.01	0.02	0.22	-0.09
2015	0.00	0.00	-0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.14	0.00
2016	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00
2017	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00
2018	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00
2019	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00
2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00

Appendix S6.2 Simulation results using “high” externality elasticities

Table HC4H: The Czech Republic - high externality elasticities

Date	GDPM	L	L (d)	LPROD	OT	LT	LPRT	ON	LLN	LPRN	CONS	I	NTSVR(d)	GBORR (d)
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	5.01	5.12	250	0.31	1.91	1.66	0.25	9.38	9.42	-0.04	2.03	20.11	-2.75	4.34
2008	7.03	6.38	311	0.68	2.67	1.89	0.77	12.47	12.00	0.43	6.95	22.43	-3.66	3.46
2009	8.61	7.09	346	1.46	4.61	2.94	1.62	14.17	12.79	1.22	8.77	24.13	-3.47	2.99
2010	10.40	7.67	374	2.62	7.34	4.45	2.77	15.59	12.97	2.32	10.24	25.70	-3.02	2.76
2011	12.70	8.34	407	4.18	10.88	6.40	4.22	17.20	13.02	3.70	11.88	27.57	-2.38	2.58
2012	14.37	9.11	446	4.95	12.79	7.46	4.96	18.92	13.92	4.39	13.91	29.40	-2.32	2.25
2013	15.78	9.65	473	5.70	14.52	8.38	5.67	20.18	14.39	5.06	15.43	30.78	-2.16	2.00
2014	11.97	5.36	264	5.96	12.79	6.97	5.43	11.93	6.55	5.06	15.10	10.88	0.09	-2.12
2015	10.64	4.26	210	6.12	12.70	7.08	5.25	9.21	4.08	4.93	10.80	8.99	1.22	-1.56
2016	9.99	3.76	186	6.09	12.31	6.89	5.07	8.05	3.11	4.78	9.40	8.00	1.47	-1.19
2017	9.62	3.52	175	6.01	11.91	6.68	4.90	7.48	2.72	4.63	8.70	7.54	1.56	-1.04
2018	9.34	3.36	167	5.91	11.52	6.46	4.75	7.11	2.51	4.49	8.28	7.22	1.57	-0.99
2019	9.08	3.23	161	5.81	11.13	6.25	4.59	6.81	2.36	4.35	7.95	6.95	1.57	-0.97
2020	8.85	3.11	156	5.70	10.77	6.05	4.45	6.55	2.24	4.21	7.66	6.70	1.55	-0.96

Table HE4H: Estonia - high externality elasticities

Date	GDPM	L	L(d)	LPROD	OT	LT	LPRT	ON	LLN	LPRN	CONS	I	NTSVR (d)	GBORR (d)
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	6.66	5.10	29.24	1.39	6.51	6.05	0.43	7.55	6.97	0.55	7.23	23.50	-4.03	0.62
2008	8.02	5.19	29.78	2.52	9.79	7.87	1.78	8.42	6.28	2.02	9.07	24.79	-3.68	0.32
2009	9.60	5.13	29.46	4.10	14.69	10.57	3.73	9.06	4.79	4.08	10.63	25.37	-2.99	0.16
2010	11.54	5.00	28.80	6.12	21.00	13.92	6.22	9.66	2.79	6.68	12.27	25.64	-2.49	0.04
2011	14.13	5.01	28.97	8.63	28.99	18.09	9.23	10.49	0.59	9.85	14.50	26.18	-1.87	-0.13
2012	15.47	5.13	29.85	9.81	32.57	19.94	10.53	10.96	-0.24	11.24	15.65	26.58	-1.61	-0.22
2013	16.71	5.24	30.67	10.90	35.82	21.58	11.71	11.31	-1.04	12.48	16.70	26.54	-1.23	-0.29
2014	10.22	0.63	3.73	9.66	28.12	15.19	11.22	4.23	-6.86	11.91	9.32	5.39	2.27	-0.89
2015	9.36	0.36	2.13	9.21	26.42	14.24	10.67	3.42	-7.04	11.25	7.82	3.92	2.41	-0.61
2016	8.91	0.27	1.61	8.88	25.01	13.45	10.19	3.07	-6.91	10.72	7.19	3.29	2.22	-0.50
2017	8.74	0.33	2.01	8.63	23.96	12.93	9.77	3.00	-6.60	10.28	7.07	3.18	2.19	-0.45
2018	8.60	0.40	2.45	8.40	23.00	12.45	9.38	2.95	-6.29	9.86	7.02	3.06	2.18	-0.43
2019	8.47	0.46	2.89	8.19	22.11	12.01	9.01	2.91	-6.01	9.48	6.98	2.95	2.18	-0.42
2020	8.34	0.52	3.31	7.99	21.27	11.60	8.67	2.86	-5.74	9.12	6.96	2.84	2.18	-0.40

HG4H: Greece - high externality elasticities

Date	GDPM	L	L (d)	LPROD	OT	LT	LPRT	ON	LLN	LPRN	CONS	I	NTSVR (d)	GBORR (d)
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	1.74	1.56	62.29	0.27	2.43	2.73	-0.30	2.00	2.06	-0.06	1.28	9.42	-1.54	0.63
2008	1.59	1.34	53.76	0.35	2.19	2.30	-0.11	1.87	1.77	0.10	1.36	8.68	-1.30	0.63
2009	1.43	1.08	43.61	0.47	2.25	2.15	0.10	1.67	1.35	0.32	1.17	7.86	-0.97	0.60
2010	1.35	0.86	34.63	0.62	2.61	2.28	0.32	1.50	0.92	0.58	1.06	7.12	-0.81	0.61
2011	1.38	0.67	27.13	0.81	3.23	2.67	0.55	1.41	0.51	0.89	1.09	6.51	-0.78	0.61
2012	1.39	0.57	23.34	0.89	3.55	2.90	0.63	1.33	0.31	1.02	1.16	6.01	-0.80	0.59
2013	1.40	0.48	19.70	0.96	3.82	3.10	0.71	1.27	0.13	1.14	1.24	5.51	-0.82	0.57
2014	0.44	-0.40	-16.21	0.83	2.52	1.63	0.87	0.15	-0.99	1.16	0.53	0.12	-0.04	0.21
2015	0.47	-0.36	-15.01	0.81	2.71	1.90	0.80	0.14	-0.98	1.12	0.47	0.08	-0.15	0.17
2016	0.53	-0.33	-13.52	0.80	2.83	2.07	0.74	0.16	-0.93	1.10	0.54	0.10	-0.30	0.17
2017	0.56	-0.30	-12.56	0.79	2.87	2.15	0.71	0.18	-0.88	1.07	0.59	0.14	-0.37	0.15
2018	0.56	-0.30	-12.70	0.79	2.84	2.14	0.69	0.18	-0.87	1.05	0.57	0.14	-0.39	0.15
2019	0.53	-0.32	-13.33	0.78	2.79	2.10	0.67	0.16	-0.86	1.03	0.52	0.12	-0.39	0.14
2020	0.51	-0.33	-14.15	0.77	2.73	2.06	0.66	0.14	-0.87	1.02	0.46	0.09	-0.38	0.14

Table HGE4H: East Germany - high externality elasticities

Date	GDPM	L	L(d)	LPROD	OT	LT	LPRT	ON	LLN	LPRN	CONS	I	NTSVR (d)	DEFR (d)
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	1.00	0.97	68.88	0.03	0.78	0.71	0.06	0.81	0.77	0.04	0.94	2.39	-0.54	0.15
2008	1.07	0.98	68.76	0.09	0.99	0.84	0.15	0.86	0.74	0.12	1.01	2.41	-0.54	0.16
2009	1.11	0.93	64.70	0.19	1.27	0.98	0.29	0.88	0.62	0.25	1.02	2.36	-0.52	0.16
2010	1.17	0.87	60.10	0.31	1.63	1.17	0.46	0.89	0.48	0.41	1.04	2.31	-0.49	0.16
2011	1.24	0.80	55.13	0.45	2.07	1.40	0.66	0.91	0.31	0.60	1.06	2.26	-0.45	0.17
2012	1.26	0.76	52.24	0.51	2.24	1.49	0.74	0.91	0.23	0.68	1.06	2.21	-0.44	0.17
2013	1.28	0.73	49.95	0.56	2.39	1.56	0.82	0.92	0.17	0.75	1.06	2.17	-0.41	0.16
2014	0.37	-0.17	-11.57	0.55	1.63	0.88	0.75	0.14	-0.55	0.70	0.15	0.00	0.07	0.03
2015	0.34	-0.17	-11.48	0.52	1.54	0.83	0.71	0.12	-0.54	0.66	0.12	-0.01	0.08	0.03
2016	0.33	-0.15	-10.40	0.50	1.47	0.79	0.67	0.12	-0.50	0.63	0.13	0.00	0.08	0.03
2017	0.32	-0.14	-9.48	0.47	1.40	0.76	0.64	0.12	-0.47	0.60	0.13	0.00	0.08	0.02
2018	0.31	-0.13	-8.64	0.45	1.34	0.72	0.61	0.12	-0.45	0.57	0.13	0.01	0.08	0.02
2019	0.30	-0.12	-7.88	0.43	1.28	0.69	0.58	0.12	-0.42	0.55	0.13	0.01	0.08	0.02
2020	0.30	-0.11	-7.19	0.41	1.22	0.66	0.55	0.12	-0.40	0.52	0.13	0.01	0.08	0.02

Table HH4H: Hungary - high externality elasticities

Date	GDPM	L	L(d)	LPROD	OT	LT	LPRT	ON	LLN	LPRN	CONS	I	NTSVR (d)	GBORR (d)
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	4.08	3.79	138	0.48	1.40	1.08	0.32	7.96	7.56	0.37	2.69	30.95	-3.80	1.04
2008	4.64	3.68	133	1.10	2.47	1.30	1.15	8.46	7.16	1.21	3.46	33.14	-3.16	0.41
2009	6.00	3.91	141	2.25	5.09	2.66	2.37	9.49	6.90	2.42	4.22	35.48	-2.67	0.16
2010	7.78	4.06	145	3.92	8.70	4.52	4.00	10.43	6.14	4.04	5.25	37.62	-2.35	-0.07
2011	10.18	4.20	149	6.22	13.41	6.90	6.09	11.53	5.10	6.12	6.42	40.10	-1.81	-0.27
2012	11.54	4.28	151	7.54	15.88	8.11	7.18	12.10	4.57	7.20	7.01	41.63	-1.53	-0.39
2013	12.98	4.39	154	8.89	18.30	9.31	8.22	12.69	4.12	8.23	7.68	43.06	-1.23	-0.48
2014	8.57	-0.14	-4.91	9.30	16.37	7.87	7.88	2.65	-4.80	7.83	3.96	3.77	3.21	-1.70
2015	8.70	0.02	0.65	9.36	16.43	8.30	7.51	2.41	-4.68	7.44	3.16	2.52	3.03	-1.07
2016	8.57	-0.09	-2.97	9.32	15.84	8.04	7.23	2.04	-4.77	7.15	3.04	1.82	2.79	-0.88
2017	8.55	-0.09	-3.09	9.30	15.34	7.79	7.00	1.97	-4.63	6.93	2.91	1.80	2.76	-0.77
2018	8.53	-0.09	-3.03	9.25	14.85	7.56	6.78	1.92	-4.49	6.71	2.86	1.73	2.70	-0.73
2019	8.50	-0.09	-2.93	9.21	14.38	7.33	6.57	1.87	-4.35	6.50	2.82	1.69	2.65	-0.69
2020	8.46	-0.08	-2.84	9.15	13.92	7.11	6.36	1.82	-4.21	6.29	2.77	1.64	2.59	-0.65

Table HL4H: Latvia - high externality elasticities

Date	GDPM	L	L(d)	LPROD	OT	LT	LPRT	ON	LLN	LPRN	CONS	I	NTSVR (d)	GBORR (d)
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	8.84	6.43	62.99	2.40	4.86	4.43	0.41	11.38	11.41	-0.03	9.02	27.90	-3.85	0.04
2008	9.62	6.34	62.39	3.25	7.30	5.64	1.58	11.96	10.66	1.18	9.53	28.26	-3.83	-0.34
2009	10.73	6.13	60.61	4.55	11.08	7.46	3.37	12.75	9.43	3.04	10.25	28.61	-3.86	-0.24
2010	12.18	5.83	57.98	6.27	16.15	9.87	5.72	13.74	7.84	5.47	11.18	28.92	-3.89	-0.13
2011	13.97	5.48	54.87	8.40	22.55	12.85	8.60	14.93	5.97	8.46	12.39	29.24	-3.89	-0.04
2012	14.91	5.42	54.59	9.39	25.58	14.27	9.90	15.57	5.26	9.80	12.96	29.67	-4.01	0.05
2013	15.80	5.35	54.34	10.32	28.44	15.61	11.10	16.15	4.60	11.04	13.58	29.85	-4.01	0.15
2014	4.63	-2.28	-23.39	7.43	21.31	9.70	10.58	2.30	-7.91	11.09	1.46	-0.97	0.64	0.01
2015	4.46	-2.21	-22.84	7.14	20.30	9.28	10.08	2.23	-7.53	10.55	1.48	-0.90	0.62	0.60
2016	4.29	-2.14	-22.38	6.87	19.35	8.89	9.60	2.15	-7.17	10.05	1.49	-0.87	0.62	0.55
2017	4.14	-2.08	-21.95	6.62	18.47	8.53	9.16	2.08	-6.84	9.57	1.51	-0.84	0.61	0.50
2018	3.99	-2.02	-21.56	6.38	17.64	8.18	8.74	2.01	-6.52	9.13	1.54	-0.81	0.61	0.46
2019	3.85	-1.96	-21.22	6.16	16.86	7.86	8.35	1.95	-6.22	8.71	1.56	-0.78	0.60	0.42
2020	3.71	-1.91	-20.94	5.95	16.13	7.55	7.98	1.89	-5.93	8.32	1.58	-0.75	0.59	0.38

Table HMZ4H: The Italian *Mezzogiorno* - high externality elasticities

Date	GDPM	L	L(d)	LPROD	OT	LT	LPRT	ON	LLN	LPRN	CONS	I	NTSVR (d)	GBORR (d)
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	1.97	1.72	115	0.25	1.60	1.42	0.18	2.70	2.57	0.13	1.39	12.10	-1.35	-0.89
2008	1.79	1.40	94.07	0.38	1.06	0.72	0.34	2.54	2.18	0.35	1.31	12.05	-1.44	-1.02
2009	1.87	1.26	84.75	0.60	1.50	0.85	0.65	2.55	1.88	0.65	1.19	12.00	-1.12	-1.00
2010	2.08	1.17	78.68	0.90	2.51	1.43	1.07	2.61	1.57	1.03	1.20	11.88	-0.89	-0.99
2011	2.44	1.13	76.63	1.29	3.94	2.31	1.59	2.79	1.28	1.49	1.40	11.86	-0.72	-0.93
2012	2.66	1.16	78.48	1.49	4.77	2.87	1.85	2.91	1.18	1.71	1.58	11.84	-0.67	-0.87
2013	2.87	1.17	79.83	1.68	5.51	3.35	2.09	3.03	1.08	1.93	1.77	11.79	-0.63	-0.82
2014	1.10	-0.34	-23.43	1.45	4.10	2.13	1.93	0.67	-1.11	1.80	0.60	0.81	0.49	0.03
2015	1.35	-0.07	-4.82	1.42	4.86	2.92	1.88	0.85	-0.83	1.70	0.77	0.69	0.63	0.20
2016	1.43	0.04	2.65	1.39	5.01	3.13	1.82	0.92	-0.69	1.62	1.01	0.62	0.44	0.24
2017	1.46	0.10	7.11	1.36	4.93	3.11	1.76	0.98	-0.57	1.56	1.15	0.67	0.35	0.28
2018	1.44	0.11	7.79	1.33	4.76	3.00	1.70	0.98	-0.53	1.51	1.16	0.68	0.31	0.28
2019	1.40	0.11	7.70	1.29	4.58	2.89	1.65	0.95	-0.50	1.46	1.14	0.66	0.31	0.27
2020	1.37	0.11	7.53	1.26	4.42	2.78	1.59	0.93	-0.48	1.41	1.11	0.64	0.30	0.26

Table HP4H: Portugal - high externality elasticities

Date	GDPM	L	L(d)	LPROD	OT	LT	LPRT	ON	LLN	LPRN	CONS	I	NTSVR (d)	GBORR (d)
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	2.06	1.61	78.47	0.60	1.62	1.60	0.02	2.78	2.61	0.16	1.45	6.84	-1.16	0.52
2008	2.02	1.35	65.92	0.84	1.86	1.45	0.40	2.67	2.14	0.52	1.57	6.54	-0.75	0.54
2009	2.10	1.13	54.99	1.21	2.94	2.02	0.91	2.47	1.39	1.06	1.30	6.24	-0.19	0.47
2010	2.54	1.04	50.63	1.75	4.61	3.02	1.54	2.52	0.74	1.77	1.64	6.11	-0.09	0.55
2011	3.20	1.02	49.38	2.42	6.71	4.30	2.31	2.70	0.08	2.62	2.36	6.04	0.02	0.59
2012	3.57	1.05	50.88	2.73	7.71	4.92	2.65	2.84	-0.16	3.00	2.87	6.01	0.05	0.61
2013	3.89	1.07	51.89	3.01	8.59	5.46	2.97	2.95	-0.39	3.35	3.31	5.95	0.11	0.63
2014	2.39	-0.07	-3.36	2.50	7.24	4.23	2.88	0.86	-2.23	3.16	2.54	0.12	0.93	0.19
2015	2.60	0.16	7.53	2.43	7.42	4.60	2.70	1.01	-1.94	3.01	2.86	0.24	0.64	0.14
2016	2.82	0.34	16.63	2.38	7.30	4.62	2.56	1.27	-1.56	2.87	3.47	0.42	0.28	0.18
2017	2.80	0.39	19.02	2.29	7.00	4.45	2.45	1.32	-1.38	2.74	3.57	0.47	0.30	0.14
2018	2.69	0.39	18.80	2.19	6.66	4.22	2.34	1.28	-1.30	2.62	3.43	0.45	0.35	0.13
2019	2.63	0.41	19.97	2.11	6.39	4.07	2.23	1.27	-1.19	2.50	3.38	0.46	0.35	0.13
2020	2.59	0.45	21.59	2.03	6.14	3.94	2.12	1.29	-1.07	2.38	3.39	0.48	0.32	0.12

Table HPO4H: Poland - high externality elasticities

Date	GDPM	L	L (d)	LPROD	OT	LT	LPRT	ON	LLN	LPRN	CONS	I	NTSVR (d)	GBORR (d)
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	6.89	4.86	651	1.80	6.43	5.99	0.41	8.58	8.26	0.30	7.78	31.52	-2.99	-0.59
2008	7.81	4.76	638	2.65	8.18	6.61	1.47	9.25	7.82	1.33	9.48	32.01	-2.50	-1.15
2009	8.87	4.53	608	3.98	12.03	8.76	3.00	9.48	6.43	2.86	9.96	32.27	-2.44	-1.23
2010	10.29	4.23	570	5.77	17.23	11.65	5.00	9.69	4.60	4.86	10.55	31.99	-2.29	-1.22
2011	12.20	3.94	531	8.07	23.96	15.34	7.47	10.01	2.49	7.34	11.41	31.77	-2.08	-1.23
2012	13.15	3.78	511	9.25	27.25	17.13	8.64	10.12	1.48	8.52	11.77	31.50	-1.96	-1.22
2013	14.07	3.62	491	10.39	30.36	18.79	9.74	10.21	0.54	9.62	12.13	31.02	-1.80	-1.22
2014	7.46	-0.68	-92.97	8.68	23.24	12.69	9.37	2.21	-6.54	9.36	4.61	2.11	0.81	-0.90
2015	6.85	-0.89	-122	8.46	22.87	12.75	8.97	1.39	-6.99	9.00	3.01	0.76	0.66	-0.45
2016	6.60	-0.95	-130	8.27	22.07	12.35	8.65	1.20	-6.90	8.69	2.74	0.18	0.67	-0.32
2017	6.46	-0.96	-132	8.14	21.41	12.02	8.38	1.13	-6.74	8.43	2.61	0.08	0.65	-0.28
2018	6.33	-0.96	-133	8.01	20.80	11.71	8.14	1.07	-6.57	8.18	2.50	0.01	0.62	-0.24
2019	6.21	-0.97	-134	7.90	20.22	11.41	7.90	1.02	-6.42	7.95	2.40	-0.04	0.59	-0.21
2020	6.10	-0.97	-136	7.79	19.67	11.13	7.68	0.97	-6.27	7.72	2.30	-0.08	0.56	-0.18

Table HR4H: Romania - high externality elasticities

Date	GDPM	L	L (d)	LPROD	OT	LT	LPRT	ON	LLN	LPRN	CONS	I	NTSVR (d)	GBORR (d)
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	4.88	2.56	226	2.56	2.87	2.49	0.37	6.79	6.62	0.15	2.26	26.45	-2.64	1.56
2008	6.74	3.32	297	3.72	5.14	3.93	1.17	8.85	7.93	0.86	2.75	34.63	-3.15	1.85
2009	9.32	4.25	384	5.40	8.91	6.20	2.55	11.48	9.17	2.11	3.87	43.82	-3.94	2.31
2010	10.80	4.41	403	6.73	12.97	8.28	4.33	12.22	8.13	3.79	4.37	45.46	-3.97	2.33
2011	12.65	4.60	425	8.38	18.05	10.86	6.49	13.17	6.95	5.82	5.17	47.42	-4.07	2.42
2012	13.69	4.76	446	9.23	20.52	12.11	7.51	13.82	6.59	6.78	5.56	48.98	-3.50	2.48
2013	14.71	4.93	468	10.05	22.86	13.30	8.44	14.48	6.35	7.65	6.04	50.40	-3.17	2.54
2014	4.36	-0.53	-50.51	5.16	16.56	8.03	7.90	0.78	-6.25	7.50	0.61	1.60	2.22	0.11
2015	4.82	-0.24	-23.81	5.31	16.40	8.14	7.64	1.56	-5.28	7.23	1.84	2.44	1.41	0.54
2016	4.51	-0.36	-35.95	5.11	15.69	7.76	7.36	1.36	-5.24	6.97	1.59	2.12	1.30	0.46
2017	4.32	-0.42	-42.00	4.96	15.09	7.47	7.09	1.31	-5.07	6.72	1.56	1.97	1.16	0.45
2018	4.13	-0.48	-48.67	4.81	14.51	7.18	6.84	1.25	-4.91	6.48	1.50	1.81	1.06	0.44
2019	3.95	-0.53	-55.15	4.67	13.96	6.91	6.60	1.18	-4.77	6.25	1.45	1.66	0.98	0.43
2020	3.77	-0.58	-61.58	4.54	13.43	6.64	6.36	1.12	-4.62	6.03	1.41	1.52	0.91	0.42

Table HS4H: Spain - high externality elasticities

Date	GDPM	L	L(d)	LPROD	OT	LT	LPRT	ON	LLN	LPRN	CONS	I	NTSVR (d)	GBORR (d)
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	0.65	0.54	88.79	0.13	0.67	0.61	0.06	0.72	0.67	0.05	0.56	2.39	-0.45	0.14
2008	0.68	0.50	83.23	0.20	0.82	0.67	0.15	0.72	0.58	0.14	0.60	2.30	-0.42	0.14
2009	0.73	0.44	74.39	0.30	1.08	0.79	0.28	0.71	0.45	0.26	0.64	2.19	-0.37	0.13
2010	0.81	0.38	64.40	0.44	1.44	0.98	0.46	0.71	0.28	0.43	0.69	2.08	-0.32	0.13
2011	0.92	0.32	54.27	0.62	1.91	1.23	0.68	0.72	0.09	0.63	0.76	1.99	-0.27	0.13
2012	0.97	0.29	50.38	0.70	2.15	1.36	0.77	0.72	0.00	0.72	0.81	1.92	-0.26	0.13
2013	1.03	0.27	47.18	0.77	2.37	1.49	0.86	0.73	-0.07	0.80	0.86	1.84	-0.24	0.13
2014	0.58	-0.10	-18.25	0.69	1.93	1.10	0.82	0.22	-0.54	0.76	0.48	0.19	0.05	0.02
2015	0.59	-0.08	-15.14	0.68	1.92	1.12	0.79	0.22	-0.51	0.74	0.49	0.17	0.03	0.02
2016	0.60	-0.07	-12.27	0.66	1.91	1.13	0.77	0.22	-0.49	0.71	0.50	0.17	0.02	0.02
2017	0.60	-0.05	-9.74	0.65	1.90	1.14	0.75	0.23	-0.47	0.70	0.51	0.17	0.01	0.02
2018	0.61	-0.04	-7.91	0.64	1.87	1.13	0.73	0.23	-0.45	0.68	0.51	0.16	0.00	0.02
2019	0.61	-0.04	-6.58	0.64	1.85	1.12	0.72	0.23	-0.43	0.66	0.51	0.16	0.00	0.01
2020	0.60	-0.03	-5.57	0.63	1.82	1.11	0.70	0.22	-0.42	0.65	0.50	0.15	0.00	0.01

Table HSL4H: Slovenia - high externality elasticities														
Date	GDPM	L	L (d)	LPROD	OT	LT	LPRT	ON	LLN	LPRN	CONS	I	NTSVR (d)	GBORR (d)
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2007	5.13	4.97	45.19	0.43	4.00	3.73	0.25	8.10	7.56	0.50	4.16	19.89	-2.07	-0.62
2008	5.49	4.87	44.35	0.90	5.19	4.39	0.77	8.03	6.98	0.98	4.37	19.36	-1.87	-0.73
2009	6.15	4.75	43.38	1.68	7.12	5.47	1.57	8.01	6.19	1.72	4.75	18.77	-1.66	-0.76
2010	7.10	4.62	42.40	2.76	9.75	6.94	2.62	8.07	5.22	2.70	5.30	18.14	-1.45	-0.81
2011	8.36	4.51	41.51	4.15	13.04	8.80	3.90	8.19	4.14	3.89	6.03	17.49	-1.21	-0.88
2012	8.94	4.39	40.53	4.86	14.57	9.66	4.47	8.10	3.53	4.41	6.27	16.83	-1.07	-0.87
2013	9.53	4.28	39.71	5.55	15.98	10.46	5.00	8.05	3.01	4.89	6.58	16.21	-0.89	-0.86
2014	4.85	-0.20	-1.90	5.37	11.99	6.94	4.73	0.86	-3.39	4.40	2.63	-1.18	0.97	-0.39
2015	4.74	-0.23	-2.20	5.29	11.53	6.69	4.53	0.81	-3.27	4.22	2.58	-1.28	0.93	-0.26
2016	4.66	-0.24	-2.30	5.20	11.10	6.47	4.35	0.80	-3.12	4.05	2.55	-1.29	0.90	-0.24
2017	4.59	-0.25	-2.34	5.12	10.70	6.26	4.17	0.79	-2.97	3.88	2.54	-1.28	0.87	-0.23
2018	4.52	-0.25	-2.34	5.04	10.31	6.06	4.01	0.80	-2.83	3.73	2.52	-1.27	0.85	-0.22
2019	4.46	-0.24	-2.33	4.96	9.95	5.87	3.85	0.80	-2.69	3.59	2.51	-1.25	0.82	-0.21
2020	4.40	-0.24	-2.29	4.88	9.61	5.69	3.71	0.81	-2.56	3.45	2.50	-1.23	0.80	-0.20

[7] Structural Funds and trade

7.1 The HERMIN model and the treatment of international trade

The HERMIN macro-model family does not model or address directly the trade flows of the economies to be modelled. It deals, however, with various interactions of the country with the rest of the world, particularly in the form of world demand (through demand in the country's export markets), world prices, and Structural Fund (SF) transfers from abroad. Aggregate exports and imports are introduced simply as constituents of the net trade surplus (NTS) in the GDP equations.

In order to establish a satellite trade module for the HERMIN model one has to start with selecting crucial variables of the model that have close and well-defined relationship with trade developments, either through identities, or in a behavioural manner. Here we identified the net trade surplus (NTS) and the development of GDP at market prices (GDPM in the model) as variables that constitute a bridge between HERMIN and the trade module.

One also has to use additional information about the past, present, and likely future trade developments in the countries under investigation, partly from theories and research results, and partly from available statistics. Here the literature of trade developments in transition countries and the gravity model framework is of particular interest.

7.2 Structural Fund programs and their trade impact

We should also form a picture about the expected trade developments due to the application of Structural Fund programs in the recipient countries. This is all the more important because the existing literature on modelling the impact of Structural Fund support is silent on this theme. As a start we can assume that the bulk of the new convergence and cohesion funds will be used to develop physical and human infrastructure. This implies smaller manufactured import contents than one is accustomed to in the course of the export-led growth strategy that most of the new and candidate states have so far pursued or intend to pursue. This means that the use of the Structural Funds would not generate a particularly strong injection of imports in the form of raw materials and semi-manufactured products (as reflected in the HERMIN variable FDOT, an output-weighted measure of domestic demand).

The development of physical infrastructure due to the Structural Funds implies, however, a substantial 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 growth of private consumption, one should expect an upturn in the import of consumer goods as well. The development of human infrastructure may also have 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 SF period, additional exports due to the Structural Funds interventions are expected to emerge from the middle of the period and spread out far beyond it. It is envisaged that the infrastructural developments will do away with bottlenecks to expanding certain economic activities that produce also for export. By the end of the SF period we may expect a certain production diversion development: capacities that served development activities within the country, have to look for other markets due the phasing out of SF related investments.

7.3 A framework for the trade module

We should make clear at the start that trade impacts can be modelled only for such SF 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 either misleading because they contained all external exchanges, including those with the "mother country" which have nothing to do with international trade, or incomplete 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 three current cohesion countries (Greece, Portugal and Spain), as well as new and candidate member states. From the latter we will focus on the countries for which HERMIN models are presented in this report, i.e., Estonia, Latvia, Poland, the Czech Republic, Hungary, Romania and Slovenia.

The Central and East European new EU member states and candidate states have an impressive 15 years of development behind them in terms of building up trade relations in general, and of orienting their trade towards the EU, in particular. Table T1 (in the Appendix to this section) shows that most of the new and candidate Central and East European members of the union 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 many of the old member states.

The lesson from this picture is that, while the ten Central and East European countries join the EU (from the point of view of international trade policy, a customs union) in 2004 and possibly 2007, contrary to what international economics suggests, they would not increase substantially their integration with the EU (through the processes of trade creation and diversion), because they have accomplished this already in the past decade.[50] 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 we expect that neither

[50] C.f. 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

accession, nor convergence and increasing cohesion would dramatically make them more open to trade.

The modelling of trade implications of alternative development paths consists of three steps:

i. Projecting general trends of trade developments in the SF recipient countries in the period 2007-2020;

ii. Calculating alternative paths of aggregate exports and imports in the recipient countries according to the base-run and the SF-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, we focus on the relationship between real growth of GDP and real growth of total exports/imports. Experience shows that the average elasticity of exports to GDP in the period 1994-2001 was 2.6 in the EU 15 group, and 2.0 in the group of the new members and candidates.[51] The same elasticity was, however, much lower in the 1980s (in 1980-1989): for the EU 15 this indicator was 1.6.[52]

It is most likely that trade elasticities in the period of the impact of SF funds, in the years 2007-2020, will be gradually lower than those experienced in the 1990s. Trade elasticities in our calculations make the link between the growth rate of GDP for the base-run and for the SF-run on the one hand, and the growth of trade variables (X and M), on the other.

(ii) Calculating alternative paths of aggregate exports and imports

Using the starting values of X and M in the year 2000, and applying a gradually declining pattern of trade elasticities, we project trade developments for the period after 2000. From the year 2007 onwards, however, differences emerge between the two growth paths (the base- and SF-related growth paths) in two respects: the growth rates of the GDP differ ($GDPMDOT_B$ and $GDPMDOT_{SF}$, according to our notation), as well as the values of the net trade surplus (NTS_B and NTS_{SF}) deviate from each other. To calculate aggregate trade paths for 2007-2020 we make assumptions based on the expected pattern of exports and imports in the period when structural and cohesion programs are carried out and in the period afterwards.[53]

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[51] The selection of the two periods for the investigation of trade elasticities was determined by the need to exclude the years of 1990-1993, the most turbulent period of transitional recession in the transition economies.

[52] In the 1980s, however, most of the new member countries did not yet exist in their current form.

[53] More precisely, we assume that the difference in the trade deficits (NTS_{SF} - NTS_B) is

(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 idea of the gravity model of trade and the results of a recent calculation of a gravity model. The results of this work are relatively well-documented for our purposes. 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 trade with certain trade destinations in order to catch up with the potential level of trade.

The results that we make use of here are taken from a recent careful estimation exercise by the International Trade Centre of UNCTAD/WTO. The TradeSim2 gravity model was developed mostly for developing and transition countries.[54] The results are available for all new EU member and accession countries, showing in which trade directions are exports/imports very high (more than 30% higher) compared to potential trade, and to which direction are exports/imports very low (more than 30% lower), and to which direction are exports/imports more or less according to their potential. Using these documented differences to potential trade, we correct (upwards or downwards) our trade elasticities for various destinations of export and sources of imports, to arrive at country-specific trade impacts.[55]

7.4 Results of the calculations

The HERMIN modelling exercise produces, among other things, alternative growth paths of GDP and net trade surplus (NTS) for the modelled countries. Based on these alternative scenarios, the trade module calculates bilateral trade developments according to the base-run and the SF-run for 2000-2020. The main outputs of the trade module are additional exports and additional imports, emerging as an impact of the SF interventions, i.e. exports and imports in addition to those export and import volumes that characterize the base run.[56]

"absorbed" by larger imports in the SF run (M_{SF}) compared to the base run (M_B) in the period 2007-2013, while the difference thereafter is absorbed by the larger exports in the SF run (X_{SF}) compared to the base run (X_B).

[54] UNCTAD/WTO (2003) *TradeSim (second version), a gravity model for the calculation of trade potentials for developing countries and economies in transition: explanatory notes*, International Trade Center, Market Analysis Section, UNCTAD/WTO, May 2003

[55] The TradeSim documentation does not provide results for all the partner countries: for the missing destinations we used unitary elasticities.

[56] The trade simulations are carried out separately for each of the modeled countries. Due to the lack of an appropriate integrated model and of data for all the partner countries, full consistency between the projections could not be ensured.

7.4.1 Additional imports due the SF intervention in recipient countries

The results of our calculations on additional imports are presented in the tables T2-A, T2-B, and T2-C of the Appendix to this section. Table T2-A presents aggregate data for the modelled SF-recipient countries. Table T2-B shows the distribution of additional imports among the import recipients and the suppliers of additional imports. And finally, Table T2-C presents the detailed annual development of the additional imports for the SF-recipient countries.

Let us explain the relationship of the data in the tables on an example. In Table T2-C, in the block of the Czech Republic, at the bottom of the first column we find the number 86,323 (EUR million), which indicates the cumulative additional imports to the Czech Republic from EU 15 due to SF interventions in the period 2007-2020. To the right of this is 99,743 (EUR million) and it refers to additional imports from EU 27. The sum of all such cumulative import volumes for the 10 countries can be found in Table T2-A, at the bottom of the first and second columns, and these are 405,258 and 446,970 (EUR million). The share of the Czech Republic as a recipient of these aggregate cumulated sums is presented in Table T2-B, in the upper block, in the first and second columns, first row, and they are 21 and 22 (%). Finally, in table T2-B, in the lower block, in the first column, the first number is 5 (%), and it shows Austria's contribution (as a source country) to the total cumulated import volume of 446,970 (EUR million) originating in EU 27.

Due to the framework conditions of the present simulation exercise, Structural Fund interventions "hit" the recipient countries without any gradual build-up. This arises because we are forced to assume that the planned SF financial expenditures, as provided by DG Regional Policy, will be implemented as actual investment programmes with exactly the same time profile. In reality, of course, there is likely to be a much more gradual build-up of activities on the ground, with perhaps considerable under-spending in the early years, and over-spending (or catch-up) in the later years. The activity profile could also be influenced by the "n+2" rule, which will permit the activities of the 2007-2003 programme to continue to the end of year 2015.

In light of the assumed sudden build-up in investment activity in the start year, 2007, the results in Table 2-A indicate a massive inflow additional imports right from the beginning of the SF-period, i.e. from 2007. The development pattern of additional imports show a jump in 2007, fast growth in the next year, a gradual increase until 2013, a drop following the termination of the SF-financing, i.e. in 2014, and again a gradual growth of the import volumes afterwards.[57]

One has to emphasize here that the table shows *additional* imports due to the SF-intervention episode in 2007-2013. Accordingly, when this amount drops following the end of the episode, i.e. from the year 2014 onwards, there still remains a total of 36-41

[57] Interestingly, the final volume of additional imports is close to the one in 2007, i.e. in the year of the jump of imports.

billion euro imports from the world routinely used every year by the recipient countries over and above what they would have used, had the SF-intervention in 2007-2013 never taken place.

Table 2-A also shows that about 68-69% of the additional imports would come from the EU 27 (the current EU 25 plus Bulgaria and Romania), and, within this, 62-63% of the total additional imports from the old member countries of EU 15. The pattern of development of imports in the individual SF-recipient countries almost fully coincides with the general scheme described above (see Table T2-C). Only Greece and Spain show some deviation: from their additional import flows, the largest volume is realized earlier, in the first years of the cohesion period, rather than at the end.

Table T2-B shows that, from the cumulated additional import volumes triggered by the SF-interventions in the period 2007-2013, Poland would absorb the most (26%), followed by the Czech Republic (21-22%), Hungary(15-16%) and Portugal (10-12%). Given the framework of our trade module, three main factors determine these relative shares:

a) The size of the country (in terms of the absolute size of GDP);
b) The openness of the country;
c) The benefit of the country from SF-interventions in terms of additional GDP growth.

It seems that from the three leading countries above (Poland, the Czech Republic, and Hungary), Poland achieves relatively high additional imports due to its size, the Czech Republic due to its high openness, size, and relatively ample benefit to GDP growth from the SF-interventions, while Hungary utilizes its openness and size.

The lower block of Table T2-B shows that the leading suppliers of the additional imports from the EU 27 are Germany, Italy and France, followed by the UK, Spain, the Netherlands and Austria. It is clear that from the additional import opportunities, the main beneficiary would be Germany by a very large margin.

7.4.2 Additional exports due the SF intervention in recipient countries

According to the results presented in tables T3-A, T3-B, and T3-C, additional exports due to SF-interventions would also start appearing at the start of the SF-period (see particularly Table T3-A). At this stage the size of additional exports, however, would be substantially lower than that of additional imports. In fact, in the first three years of the SF-period, total additional imports from the world would be more than twice as large as the volume of additional exports. Additional exports would overcome the size of additional imports only in the first year following the SF period, i.e. in the year 2014.[58] In the subsequent years additional exports would grow steadily, although with a moderate rate.

[58] We have to admit that this coincidence is partly the implication of the methodology that we applied in the trade module, partly, however, is due to the differences between the values of the net trade surplus variable (NTS) in the base-run and the SF-run of the HERMIN simulations.

From Table T3-A, we can also calculate that 69-70% of the additional exports would go to the old member countries of EU 15, while 78-79% of it would find its market in the EU 27. When looking at the evolution of additional exports in the individual SF-recipient countries (Table T3-C), we find different patterns of development. For example, Hungary, Poland, Portugal and Spain, after the initial jump in 2007 follow the general scheme of gradual development of additional exports described above. The Czech Republic, Estonia, Latvia and Romania, however, experience a peak in their additional exports in the year 2013, followed by a moderate decline and then a recovery to 2020, while additional exports in Greece experience a second jump in 2014 and a subsequent growth period.

Table T3-B shows that the lion's share of the additional exports from the SF-recipient countries would originate in Poland, the Czech Republic and Hungary. The performance of the traditionally open economies of the Czech Republic and Hungary is not a surprise. The considerable weight of Poland in total additional exports, however, is a surprise, and it probably has to do with the size of that economy.

Among the main destinations of the additional exports we find again that Germany is a prominent target market (with 39% share), followed (at a considerable distance) by Italy, France, the United Kingdom, and Austria.

7.4.3 Comparison of SF financing by the EU with implied trade volumes

We now compare the export and import volumes that emerge as a consequence of the SF interventions with the SF financing that is planned to be transferred from the Community budget to the recipient countries in the period 2007-2020. As in the previous sections, all data are expressed in constant 2004 euro.

In Table T4-A, SF financing in the financial framework period 2007-2013 is set against the trade implications of the SF programs. Here, the trade flows of the recipient countries with the EU 27 are presented, since SF financing also would come from EU 27.[59]

Table T4-A shows that already by the first year of the program, in the year 2007, total additional imports from the EU 27 would be higher than financing provided for the SF programs. In each consecutive year, total additional imports would be higher than the financing, and the total cumulative imports by 2020 will be more than twice as high as total SF financing in the financial framework period 2007-2013. As we saw above, additional exports build up slower than imports. By the year 2012, however, annual additional exports equal the size of that year's financing, and by the year 2014 cumulative additional exports are greater than the size of cumulative SF financing.

Table T4-B shows the same comparison for the individual recipient countries. The picture is similar: even in the first year of the program, and also later on, the EU will find larger markets for its exports in the recipient countries (where these are counted as

[59] Or from EU 28, if Croatia manages to join the EU the same time as Bulgaria and Romania.

imports) than the yearly financing it provides for these countries. The exceptions to this rule are Greece and Spain, the two least open economies among the recipient countries. In some countries the dominance of additional imports over SF financing is particularly strong. For example, in the Czech Republic, Estonia, Latvia and Slovenia additional imports already in the first years could be twice as large as the EU financing provided for the SF programs. In cumulative terms the Czech Republic, Estonia and Hungary show strong relationships in this respect. In the Czech Republic and Estonia, by the year 2020, accumulated additional imports from the EU would be four times higher than EU's SF-financing, in Hungary imports would be three times as high as financing.

7.4.4 Trade balance for additional cumulative trade volumes in the recipient countries and in the EU 15

In this section we first analyze the trade balance effects for the countries that are recipients of SF funds, and than we present the results of calculations for the EU 15.[60]

A comparison of the cumulative additional imports and exports taken from Tables T2-A and T3-A shows that cumulative additional imports in most of the 14 years of the period under investigation (2007-2020) are substantially larger than the achieved total additional exports. By 2020, however, the difference becomes small: taking trade with the EU 15, the EU 27, and the whole world the cumulative "trade balance" for the additional trade is -2 per cent, 1 per cent, and -14 per cent (of the cumulative additional exports), respectively. The overall negative net additional trade balance with the world for the recipient countries should not be too unexpected, because the structural and cohesion programs are not primarily export development programs, on the one hand, and the period of investigation is artificially cut in 2020, on the other. By the year 2020, most of the recipient countries would have achieved trade surplus on their yearly additional exports and imports in the previous 6-7 years, and we should not doubt that they would carry this on beyond 2020.

A comparison of the cumulative additional imports and exports for the individual countries (see Tables T2-C and T3-C) shows that, in their additional trade with the world, most countries show a trade deficit in the years 2007-2020; the exceptions are the Czech Republic, Hungary, Romania and Slovenia. In their trade with the EU 27, the exceptions from the rule of showing a trade deficit are the Czech Republic, Estonia, Hungary, Romania and Slovenia. And finally, in their trade with the EU 15, Latvia joins the previous five countries in terms of achieving a trade surplus. The remaining recipient countries show a trade deficit.

Table T5 shows the results of calculations for the cumulative trade implications of the SF interventions for the EU 15 countries. As the table indicates, in the period 2007-2020 the cumulative additional exports to the 10 recipient countries would amount to EUR million 405,258 (in EUR 2004), which would be equivalent to 12.1% of the total exports of the

[60] Note that Greece, Portugal and Spain belong to both groups; however, in the two calculations different segments of their trade are investigated.

EU 15 countries in 2004, or 107.9% of the export of the EU 15 to the 10 modelled countries in the year 2004.

The trade balance for the EU 15 for the period of 2007-2020 would be moderately positive, EUR million 9,043 (in EUR 2004) or 2.2% of the relevant additional exports. The net trade effects vary from member country to member country.[61] The last rows in Table T5 present the additional trade and net trade effects split to two sub-periods. The results prove again that there are contrasting phases of the utilization of SF funds: here we see that in the first phase, all old EU member countries achieve net trade surplus on the additional trade due the SF interventions, while in the second phase, several countries export less and import more from the recipient countries based on the additional trade flows related to SF interventions.

[61] For Greece, Portugal and Spain the first analysis of this section is relevant since that took into account not only their trade with the 10 modelled countries, but their trade with EU 15, EU 27 and with the whole world.

Appendix S7 Trade impact analysis data tables

Table T1

Characteristic features of international trade of new members and candidates

Ratio of exports of goods and services to GDP, %				Share of trade with EU 27, %	
				Export	Import
	1990	1995	2001	2000	2000
EU 15					
Austria	40	37	52	75	80
Belgium	71	69	84	77	71
Denmark	36	35	46	71	72
Finland	23	37	40	63	65
France	21	23	28	64	67
Germany	29	24	35	65	60
Greece	18	18	25 *	60	63
Ireland	57	76	95	61	57
Italy	20	27	28	61	61
Luxembourg	112	109	156 *	87	84
Netherlands	54	57	65	81	53
Portugal	33	30	32	81	75
Spain	16	23	30	72	66
Sweden	30	41	46	59	69
United Kingdom	24	28	27	59	52
Average	39	42	53	69	66
New members and candidates					
Bulgaria	33	45	56	51	53
Cyprus	52	47	45 **	40	53
Czech Republic	45	54	71	86	75
Estonia		72	91	81	60
Hungary	31	37	60	84	66
Latvia		47	46	81	74
Lithuania		53	50	72	53
Malta	85	94	88	34	61
Poland	29	25	29	81	69
Romania	17	28	34	73	66
Slovak Republic	27	57	74	90	70
Slovenia		55	59 *	72	77
Average	40	51	59	70	65
CEEC 8 average	30	47	57	77	66

* in 2000
** in 1999

Source:
Own calculation based on Wolrd Economic Indicators (2003), The World Bank, Washington DC and IMF Direction of Trade Statistics, IMF, Washington DC

Table T2-A

Additional import deliveries due to the SF interventions from country groups to the modelled countries, million constant 2004 EUR

	Total		
	from EU 15	from EU 27	from World
2007	28 649	31 664	46 018
2008	32 169	35 655	51 765
2009	33 348	37 033	53 861
2010	34 096	37 869	55 088
2011	35 298	39 181	56 996
2012	36 413	40 383	58 723
2013	37 532	41 584	60 476
2014	22 523	24 836	36 029
2015	22 466	24 677	35 896
2016	23 024	25 215	36 706
2017	23 747	25 967	37 862
2018	24 462	26 720	39 032
2019	25 302	27 606	40 391
2020	26 228	28 582	41 882
Cumulative	405 258	446 970	650 725

Table T2-B

Additional imports due to SF intervention to the 10 modelled countries, million constant 2004 EUR

Distribution of cumulative additional import deliveries among the modelled countries, percent

Destination	Source of imports		
	from EU 15	from EU 27	from World
Czech R.	21	22	21
Estonia	2	2	3
Hungary	15	15	16
Latvia	1	1	1
Poland	26	26	26
Romania	5	5	5
Slovenia	3	3	3
Greece	6	5	6
Portugal	12	11	10
Spain	9	8	9
Total	100	100	100

Distribution of cumulative import from EU 27 among the sources, percent

Austria	5	Latvia	0
Belgium	4	Lithuania	0
Bulgaria	0	Luxembourg	0
Cyprus	0	Malta	0
Czech R.	2	Netherlands	5
Denmark	1	Poland	2
Estonia	0	Portugal	1
Finland	3	Romania	0
France	10	Slovakia	2
Germany	33	Slovenia	0
Greece	0	Spain	6
Hungary	1	Sweden	3
Ireland	1	United K.	7
Italy	12	Total	100

Table T2-C

Additional import deliveries due to the SF interventions from country groups to the modelled countries, million constant 2004 EUR

	Czech R.			Estonia			Hungary			Latvia			Poland		
	from EU 15	from EU 27	from World	from EU 15	from EU 27	from World	from EU 15	from EU 27	from World	from EU 15	from EU 27	from World	from EU 15	from EU 27	from World
2007	3 786	4 449	6 002	559	624	1 039	3 580	4 023	6 143	474	650	903	8 541	9 551	13 954
2008	5 375	6 302	8 520	641	714	1 188	3 941	4 423	6 761	489	668	932	9 638	10 763	15 746
2009	6 109	7 145	9 684	704	783	1 303	4 256	4 771	7 303	505	688	963	9 803	10 934	16 017
2010	6 696	7 812	10 615	761	845	1 406	4 582	5 129	7 861	523	709	997	9 739	10 848	15 912
2011	7 343	8 544	11 639	836	926	1 542	4 927	5 508	8 452	542	733	1 034	9 591	10 669	15 670
2012	8 051	9 343	12 762	893	988	1 645	5 151	5 750	8 837	561	755	1 070	9 595	10 659	15 676
2013	8 697	10 066	13 786	951	1 050	1 748	5 388	6 007	9 243	580	777	1 105	9 592	10 643	15 672
2014	6 159	7 110	9 764	512	565	940	3 356	3 736	5 758	115	154	219	5 421	6 007	8 856
2015	5 511	6 344	8 736	482	530	882	3 583	3 983	6 147	118	156	225	5 225	5 783	8 537
2016	5 390	6 187	8 544	482	529	881	3 680	4 084	6 314	120	159	229	5 309	5 868	8 674
2017	5 493	6 287	8 707	507	556	924	3 849	4 265	6 603	123	162	235	5 475	6 043	8 945
2018	5 675	6 477	8 996	537	587	976	4 038	4 467	6 927	127	166	241	5 659	6 239	9 246
2019	5 896	6 710	9 346	570	622	1 034	4 242	4 685	7 277	130	170	249	5 856	6 448	9 568
2020	6 141	6 969	9 735	607	661	1 097	4 462	4 920	7 655	135	175	257	6 067	6 671	9 912
Cumulative	86 323	99 743	136 836	9 044	9 979	16 605	59 033	65 753	101 281	4 542	6 121	8 659	105 511	117 126	172 387
	Romania			Slovenia			Greece			Portugal			Spain		
	from EU 15	from EU 27	from World	from EU 15	from EU 27	from World	from EU 15	from EU 27	from World	from EU 15	from EU 27	from World	from EU 15	from EU 27	from World
2007	1 469	1 681	2 591	1 145	1 286	1 688	2 208	2 374	3 756	3 584	3 652	4 835	3 304	3 375	5 107
2008	1 787	2 041	3 153	1 141	1 279	1 682	2 201	2 367	3 745	3 648	3 718	4 922	3 310	3 381	5 116
2009	2 302	2 623	4 060	1 148	1 286	1 692	2 012	2 164	3 424	3 282	3 346	4 429	3 226	3 295	4 986
2010	2 362	2 686	4 166	1 165	1 303	1 718	1 829	1 967	3 113	3 318	3 383	4 477	3 120	3 187	4 823
2011	2 499	2 837	4 409	1 192	1 331	1 757	1 723	1 851	2 931	3 619	3 690	4 883	3 027	3 092	4 678
2012	2 427	2 749	4 282	1 192	1 330	1 758	1 660	1 785	2 825	3 918	3 995	5 287	2 964	3 028	4 582
2013	2 422	2 738	4 273	1 200	1 336	1 769	1 609	1 729	2 738	4 185	4 267	5 646	2 909	2 972	4 496
2014	529	597	933	432	481	638	1 240	1 333	2 111	2 759	2 814	3 723	1 998	2 041	3 087
2015	671	755	1 184	438	487	646	1 278	1 373	2 174	3 111	3 173	4 198	2 049	2 093	3 167
2016	663	745	1 170	448	496	660	1 326	1 425	2 257	3 498	3 568	4 719	2 108	2 154	3 258
2017	680	762	1 199	458	507	675	1 368	1 470	2 329	3 622	3 696	4 888	2 171	2 219	3 356
2018	694	777	1 225	469	519	692	1 396	1 499	2 375	3 636	3 710	4 906	2 230	2 278	3 446
2019	711	794	1 254	482	531	710	1 418	1 522	2 412	3 712	3 788	5 009	2 285	2 335	3 532
2020	728	811	1 284	495	545	729	1 438	1 544	2 447	3 817	3 896	5 151	2 339	2 390	3 615
Cumulative	19 944	22 596	35 183	11 404	12 717	16 816	22 707	24 402	38 637	49 710	50 695	67 072	37 041	37 840	57 248

Table T3-A

Additional export deliveries due to the SF interventions from the modelled countries to country groups, million constant 2004 EUR

	Total		
	to EU 15	to EU 27	to World
2007	13 323	15 252	19 363
2008	15 524	17 848	22 600
2009	17 815	20 500	25 938
2010	20 484	23 540	29 753
2011	24 049	27 590	34 846
2012	26 684	30 585	38 632
2013	29 403	33 669	42 537
2014	31 491	35 849	45 664
2015	33 730	38 269	48 708
2016	34 462	39 053	49 745
2017	35 436	40 109	51 099
2018	36 607	41 384	52 734
2019	37 907	42 806	54 552
2020	39 299	44 332	56 499
Cumulative	396 215	450 786	572 671

Table T3-B

Additional exports due to SF intervention from the 10 modelled countries, million constant 2004 EUR

Distribution of cumulative additional export deliveries among the modelled countries, percent

Source of exports	Destination: to EU 15	to EU 27	to World
Czech R.	24	26	25
Estonia	3	3	3
Hungary	21	20	18
Latvia	1	1	1
Poland	25	25	25
Romania	5	6	6
Slovenia	3	3	3
Greece	2	3	3
Portugal	9	8	7
Spain	7	7	8
Total	100	100	100

Distribution of cumulative exports to EU 27 among the destinations, percent

Austria	6	Latvia	0
Belgium	3	Lithuania	1
Bulgaria	1	Luxembourg	0
Cyprus	0	Malta	0
Czech R.	1	Netherlands	5
Denmark	2	Poland	2
Estonia	0	Portugal	1
Finland	1	Romania	1
France	8	Slovakia	3
Germany	39	Slovenia	1
Greece	1	Spain	4
Hungary	2	Sweden	2
Ireland	1	United K.	7
Italy	9	Total	100

Table T3-C

Additional export deliveries due to the SF interventions from the modelled countries to country groups, million constant 2004 EUR

	Czech R.			Estonia			Hungary			Latvia			Poland		
	to EU 15	to EU 27	to World	to EU 15	to EU 27	to World	to EU 15	to EU 27	to World	to EU 15	to EU 27	to World	to EU 15	to EU 27	to World
2007	2 873	3 524	4 187	438	516	676	2 018	2 230	2 643	306	380	505	3 400	3 918	4 922
2008	4 043	4 945	5 894	517	608	803	2 221	2 451	2 901	332	413	552	3 841	4 420	5 573
2009	4 854	5 920	7 078	596	701	930	2 740	3 019	3 567	366	454	613	4 259	4 895	6 194
2010	5 690	6 918	8 300	682	801	1 071	3 388	3 729	4 397	407	505	687	4 761	5 464	6 938
2011	6 740	8 170	9 835	795	934	1 257	4 257	4 678	5 504	457	566	776	5 407	6 197	7 897
2012	7 653	9 247	11 171	870	1 021	1 385	4 861	5 333	6 262	493	611	845	5 825	6 668	8 527
2013	8 549	10 295	12 482	947	1 110	1 517	5 541	6 070	7 109	530	655	915	6 255	7 151	9 177
2014	7 257	8 710	10 599	692	811	1 117	6 359	6 956	8 125	252	311	438	7 913	9 034	11 635
2015	7 447	8 908	10 881	685	801	1 111	7 326	8 000	9 318	251	310	441	8 797	10 030	12 963
2016	7 603	9 063	11 113	693	810	1 132	7 633	8 321	9 662	251	309	444	9 082	10 341	13 413
2017	7 886	9 368	11 530	719	840	1 183	8 054	8 766	10 143	251	309	448	9 324	10 602	13 800
2018	8 210	9 719	12 008	750	875	1 241	8 498	9 232	10 644	252	310	453	9 573	10 870	14 199
2019	8 566	10 104	12 532	784	914	1 306	8 976	9 734	11 179	253	311	459	9 837	11 155	14 623
2020	8 948	10 518	13 096	822	957	1 377	9 491	10 274	11 749	254	313	467	10 119	11 459	15 075
Cumulative	96 320	115 408	140 706	9 990	11 701	16 106	81 364	88 792	103 205	4 654	5 758	8 043	98 393	112 206	144 935

	Romania			Slovenia			Greece			Portugal			Spain		
	to EU 15	to EU 27	to World	to EU 15	to EU 27	to World	to EU 15	to EU 27	to World	to EU 15	to EU 27	to World	to EU 15	to EU 27	to World
2007	659	771	1 069	660	738	1 019	352	483	809	1 365	1 389	1 718	1 251	1 303	1 815
2008	921	1 083	1 502	702	784	1 082	324	445	745	1 324	1 346	1 665	1 298	1 352	1 883
2009	1 282	1 519	2 104	767	855	1 179	288	395	662	1 313	1 335	1 652	1 350	1 406	1 959
2010	1 474	1 759	2 433	857	954	1 314	268	367	615	1 526	1 552	1 920	1 431	1 490	2 077
2011	1 718	2 064	2 851	974	1 083	1 491	266	364	611	1 882	1 915	2 369	1 554	1 618	2 255
2012	1 915	2 321	3 198	1 048	1 164	1 600	265	364	609	2 128	2 164	2 677	1 626	1 693	2 359
2013	2 128	2 602	3 575	1 127	1 250	1 716	265	363	608	2 359	2 400	2 969	1 703	1 773	2 471
2014	1 972	2 435	3 332	808	895	1 227	828	1 134	1 899	2 895	2 945	3 643	2 515	2 619	3 649
2015	1 633	2 037	2 775	814	900	1 232	920	1 261	2 112	3 239	3 294	4 075	2 619	2 727	3 800
2016	1 537	1 940	2 627	825	911	1 245	949	1 300	2 178	3 185	3 240	4 008	2 705	2 817	3 925
2017	1 488	1 903	2 559	839	925	1 263	952	1 305	2 185	3 141	3 195	3 952	2 781	2 896	4 035
2018	1 473	1 910	2 549	857	943	1 285	967	1 325	2 219	3 171	3 225	3 990	2 857	2 976	4 146
2019	1 475	1 941	2 567	877	963	1 310	990	1 356	2 271	3 217	3 272	4 047	2 934	3 056	4 258
2020	1 485	1 986	2 600	898	986	1 338	1 018	1 394	2 336	3 251	3 307	4 091	3 013	3 138	4 372
Cumulative	21 160	26 271	35 740	12 052	13 352	18 300	8 653	11 856	19 858	33 995	34 579	42 776	29 634	30 863	43 003

Table T4-A

Comparison of SF financing and the implied additional trade developments for the modelled 10 countries, million constant 2004 euro

	Total yearly		
	SF financing from EU 27	Add. exports to EU 27	Add. imports from EU 27
2007	25 974	15 252	31 664
2008	27 044	17 848	35 655
2009	28 091	20 500	37 033
2010	28 773	23 540	37 869
2011	29 466	27 590	39 181
2012	30 139	30 585	40 383
2013	30 828	33 669	41 584
2014	0	35 849	24 836
2015	0	38 269	24 677
2016	0	39 053	25 215
2017	0	40 109	25 967
2018	0	41 384	26 720
2019	0	42 806	27 606
2020	0	44 332	28 582
Cumulative	200 315	450 786	446 970
	Total cumulated		
	SF financing from EU 27	Add. exports to EU 27	Add. imports from EU 27
2007	25 974	15 252	31 664
2008	53 018	33 101	67 319
2009	81 109	53 600	104 352
2010	109 881	77 140	142 221
2011	139 348	104 730	181 402
2012	169 487	135 315	221 785
2013	200 315	168 984	263 369
2014	200 315	204 834	288 205
2015	200 315	243 103	312 882
2016	200 315	282 155	338 097
2017	200 315	322 264	364 063
2018	200 315	363 649	390 783
2019	200 315	406 454	418 389
2020	200 315	450 786	446 970

Table T4-B (1st part)

Comparison of SF financing and the implied additional trade developments by countries, million constant 2004 euro

	Czech R.			Estonia			Hungary			Latvia			Poland		
	SF financing from EU 27	Add. exports to EU 27	Add. imports from EU 27	SF financing from EU 27	Add. exports to EU 27	Add. imports from EU 27	SF financing from EU 27	Add. exports to EU 27	Add. imports from EU 27	SF financing from EU 27	Add. exports to EU 27	Add. imports from EU 27	SF financing from EU 27	Add. exports to EU 27	Add. imports from EU 27
2007	3 148	3 524	4 449	310	516	624	2 698	2 230	4 023	365	380	650	7 788	3 918	9 551
2008	3 275	4 945	6 302	322	608	714	2 859	2 451	4 423	379	413	668	8 090	4 420	10 763
2009	3 402	5 920	7 145	334	701	783	3 031	3 019	4 771	393	454	688	8 390	4 895	10 934
2010	3 530	6 918	7 812	346	801	845	3 217	3 729	5 129	407	505	709	8 694	5 464	10 848
2011	3 657	8 170	8 544	358	934	926	3 416	4 678	5 508	421	566	733	8 995	6 197	10 669
2012	3 795	9 247	9 343	371	1 021	988	3 543	5 333	5 750	437	611	755	9 324	6 668	10 659
2013	3 936	10 295	10 066	384	1 110	1 050	3 672	6 070	6 007	452	655	777	9 657	7 151	10 643
2014		8 710	7 110		811	565		6 956	3 736		311	154		9 034	6 007
2015		8 908	6 344		801	530		8 000	3 983		310	156		10 030	5 783
2016		9 063	6 187		810	529		8 321	4 084		309	159		10 341	5 868
2017		9 368	6 287		840	556		8 766	4 265		309	162		10 602	6 043
2018		9 719	6 477		875	587		9 232	4 467		310	166		10 870	6 239
2019		10 104	6 710		914	622		9 734	4 685		311	170		11 155	6 448
2020		10 518	6 969		957	661		10 274	4 920		313	175		11 459	6 671
Cumulative	24 744	115 408	99 743	2 423	11 701	9 979	22 435	88 792	65 753	2 855	5 758	6 121	60 938	112 206	117 126
	Cumulated amounts			Cumulated amounts			Cumulated amounts			Cumulated amounts			Cumulated amounts		
	SF financing from EU 27	Add. exports to EU 27	Add. imports from EU 27	SF financing from EU 27	Add. exports to EU 27	Add. imports from EU 27	SF financing from EU 27	Add. exports to EU 27	Add. imports from EU 27	SF financing from EU 27	Add. exports to EU 27	Add. imports from EU 27	SF financing from EU 27	Add. exports to EU 27	Add. imports from EU 27
2007	3 148	3 524	4 449	310	516	624	2 698	2 230	4 023	365	380	650	7 788	3 918	9 551
2008	6 424	8 469	10 751	631	1 124	1 338	5 557	4 681	8 446	744	793	1 317	15 878	8 339	20 314
2009	9 826	14 389	17 896	965	1 825	2 120	8 587	7 700	13 217	1 138	1 248	2 005	24 268	13 234	31 248
2010	13 356	21 307	25 708	1 310	2 626	2 965	11 804	11 429	18 346	1 545	1 753	2 714	32 962	18 698	42 096
2011	17 013	29 477	34 252	1 668	3 560	3 891	15 220	16 106	23 854	1 967	2 319	3 447	41 957	24 896	52 765
2012	20 808	38 723	43 595	2 039	4 581	4 879	18 763	21 440	29 605	2 403	2 930	4 202	51 281	31 564	63 425
2013	24 744	49 018	53 661	2 423	5 692	5 929	22 435	27 509	35 611	2 855	3 585	4 978	60 938	38 715	74 068
2014	24 744	57 728	60 770	2 423	6 503	6 494	22 435	34 465	39 348	2 855	3 896	5 132	60 938	47 750	80 074
2015	24 744	66 636	67 114	2 423	7 304	7 024	22 435	42 465	43 330	2 855	4 206	5 288	60 938	57 780	85 857
2016	24 744	75 699	73 301	2 423	8 115	7 553	22 435	50 786	47 415	2 855	4 515	5 447	60 938	68 121	91 725
2017	24 744	85 067	79 587	2 423	8 955	8 109	22 435	59 551	51 680	2 855	4 824	5 610	60 938	78 723	97 768
2018	24 744	94 786	86 064	2 423	9 830	8 696	22 435	68 784	56 147	2 855	5 134	5 776	60 938	89 593	104 007
2019	24 744	104 890	92 774	2 423	10 744	9 318	22 435	78 518	60 833	2 855	5 446	5 946	60 938	100 747	110 455
2020	24 744	115 408	99 743	2 423	11 701	9 979	22 435	88 792	65 753	2 855	5 758	6 121	60 938	112 206	117 126

Table T4-B (2nd part)

Comparison of SF financing and the implied additional trade developments by countries, million constant 2004 euro

	Romania			Slovenia			Greece			Portugal			Spain		
	SF financing from EU 27	Add. exports to EU 27	Add. imports from EU 27	SF financing from EU 27	Add. exports to EU 27	Add. imports from EU 27	SF financing from EU 27	Add. exports to EU 27	Add. imports from EU 27	SF financing from EU 27	Add. exports to EU 27	Add. imports from EU 27	SF financing from EU 27	Add. exports to EU 27	Add. imports from EU 27
2007	1 284	771	1 681	639	738	1 286	3 425	483	2 374	2 803	1 389	3 652	3 514	1 303	3 375
2008	1 738	1 083	2 041	639	784	1 279	3 425	445	2 367	2 803	1 346	3 718	3 514	1 352	3 381
2009	2 237	1 519	2 623	639	855	1 286	3 376	395	2 164	2 798	1 335	3 346	3 493	1 406	3 295
2010	2 351	1 759	2 686	639	954	1 303	3 326	367	1 967	2 792	1 552	3 383	3 471	1 490	3 187
2011	2 468	2 064	2 837	639	1 083	1 331	3 276	364	1 851	2 786	1 915	3 690	3 450	1 618	3 092
2012	2 594	2 321	2 749	639	1 164	1 330	3 227	364	1 785	2 781	2 164	3 995	3 429	1 693	3 028
2013	2 727	2 602	2 738	639	1 250	1 336	3 177	363	1 729	2 775	2 400	4 267	3 408	1 773	2 972
2014		2 435	597		895	481		1 134	1 333		2 945	2 814		2 619	2 041
2015		2 037	755		900	487		1 261	1 373		3 294	3 173		2 727	2 093
2016		1 940	745		911	496		1 300	1 425		3 240	3 568		2 817	2 154
2017		1 903	762		925	507		1 305	1 470		3 195	3 696		2 896	2 219
2018		1 910	777		943	519		1 325	1 499		3 225	3 710		2 976	2 278
2019		1 941	794		963	531		1 356	1 522		3 272	3 788		3 056	2 335
2020		1 986	811		986	545		1 394	1 544		3 307	3 896		3 138	2 390
Cumulative	15 399	26 271	22 596	4 472	13 352	12 717	23 231	11 856	24 402	19 538	34 579	50 695	24 278	30 863	37 840

	Cumulated amounts			Cumulated amounts			Cumulated amounts			Cumulated amounts			Cumulated amounts		
	SF financing from EU 27	Add. exports to EU 27	Add. imports from EU 27	SF financing from EU 27	Add. exports to EU 27	Add. imports from EU 27	SF financing from EU 27	Add. exports to EU 27	Add. imports from EU 27	SF financing from EU 27	Add. exports to EU 27	Add. imports from EU 27	SF financing from EU 27	Add. exports to EU 27	Add. imports from EU 27
2007	1 284	771	1 681	639	738	1 286	3 425	483	2 374	2 803	1 389	3 652	3 514	1 303	3 375
2008	3 022	1 855	3 722	1 278	1 523	2 565	6 850	927	4 741	5 607	2 735	7 370	7 028	2 654	6 756
2009	5 259	3 373	6 345	1 917	2 378	3 851	10 226	1 323	6 905	8 404	4 070	10 716	10 520	4 060	10 051
2010	7 610	5 132	9 031	2 555	3 332	5 154	13 552	1 690	8 871	11 196	5 623	14 099	13 992	5 551	13 238
2011	10 078	7 196	11 868	3 194	4 415	6 485	16 828	2 054	10 723	13 983	7 537	17 788	17 442	7 169	16 330
2012	12 672	9 517	14 617	3 833	5 579	7 814	20 055	2 418	12 507	16 763	9 702	21 783	20 871	8 862	19 358
2013	15 399	12 119	17 355	4 472	6 829	9 150	23 231	2 781	14 236	19 538	12 101	26 051	24 278	10 635	22 330
2014	15 399	14 554	17 952	4 472	7 724	9 631	23 231	3 915	15 569	19 538	15 046	28 865	24 278	13 254	24 371
2015	15 399	16 591	18 707	4 472	8 623	10 118	23 231	5 176	16 942	19 538	18 340	32 038	24 278	15 981	26 464
2016	15 399	18 531	19 452	4 472	9 534	10 614	23 231	6 476	18 367	19 538	21 580	35 606	24 278	18 798	28 618
2017	15 399	20 434	20 214	4 472	10 459	11 122	23 231	7 781	19 836	19 538	24 775	39 301	24 278	21 695	30 836
2018	15 399	22 344	20 991	4 472	11 403	11 640	23 231	9 105	21 336	19 538	28 001	43 011	24 278	24 670	33 115
2019	15 399	24 284	21 784	4 472	12 366	12 172	23 231	10 461	22 858	19 538	31 272	46 799	24 278	27 726	35 450
2020	15 399	26 271	22 596	4 472	13 352	12 717	23 231	11 856	24 402	19 538	34 579	50 695	24 278	30 863	37 840

Cumulative additional exports/imports from/to EU 15 due to SF interventions in the 10 modelled countries in 2007-2020, million EUR **Table T5**

	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxemb.	Netherl.	Portugal	Spain	Sweden	UK	EU 15
Cumulative additional exports																
to the 10 modelled countries in 2007-2020																
in million 2004 EUR	21 477	16 120	6 201	11 635	46 921	146 043	2 073	4 753	54 168	866	21 467	2 857	27 951	13 543	29 183	405 258
as % of total exports of the exporter in 2004	17.9	7.0	7.3	21.3	11.2	18.0	4.5	4.1	16.1	2.5	7.5	6.7	12.7	11.0	6.8	12.1
as % of total exports of the exporter to the 10 modelled countries in 2004	115.1	99.0	110.4	195.2	77.2	134.0	47.7	89.3	109.5	38.8	101.3	32.2	103.7	135.2	87.7	107.9
Cumulative additional imports																
from the 10 modelled countries in 2007-2020																
in million 2004 EUR	25 390	14 273	7 445	6 204	37 162	175 132	3 279	2 801	38 941	490	21 011	5 766	16 084	10 885	31 353	396 215
as % of total imports of the importer in 2004	21.7	6.5	10.3	14.0	9.4	24.9	7.2	3.0	11.8	1.6	8.1	11.8	6.8	10.5	6.6	12.5
as % of total imports of the importer from the 10 modelled countries in 2004	194.1	142.2	186.0	214.4	97.5	211.4	109.8	112.4	137.9	76.5	177.9	44.2	175.4	162.3	123.2	155.5
Net trade effects of the cumulative additional exports/imports in 2007-2020	-3 914	1 847	-1 245	5 432	9 758	-29 089	-1 206	1 952	15 227	376	456	-2 909	11 868	2 658	-2 170	9 043
Cumulative trade flows in subperiods,																
in million 2004 EUR																
Cumulative additional exports in 2007-2013	12 359	9 399	3 767	7 042	27 616	84 857	1 389	2 769	32 959	503	12 611	1 687	15 263	8 184	17 099	237 505
Cumulative additional exports in 2014-2020	9 118	6 721	2 434	4 593	19 305	61 186	684	1 984	21 208	363	8 856	1 170	12 688	5 359	12 084	167 752
Cumulative additional imports in 2007-2013	9 096	5 353	2 767	2 743	13 571	64 986	1 298	1 089	14 638	185	7 733	2 028	5 723	4 537	11 535	147 282
Cumulative additional imports in 2014-2020	16 294	8 920	4 678	3 461	23 591	110 146	1 981	1 712	24 303	305	13 278	3 737	10 361	6 348	19 818	248 932
Net trade effects in 2007-2013	3 263	4 046	1 000	4 300	14 045	19 871	91	1 680	18 321	318	4 878	-342	9 540	3 647	5 564	90 223
Net trade effects in 2014-2020	-7 176	-2 199	-2 244	1 132	-4 286	-48 960	-1 297	272	-3 095	58	-4 422	-2 567	2 327	-989	-7 734	-81 180

[8] Structural Funds and the environment

8.1 Introduction

Environmental modules have not yet been developed for the HERMIN model, but are available for the larger Irish HERMES model. In this report we develop a very simple environmental "satellite" module for the HERMIN model, relating the cohesion impacts on GDP to a range of environmental impacts (in particularly, the energy intensity of GDP and air pollution emission levels).

The general purpose is to model the link between the economy and the environment and to look at the impact of the Structural Funds. However, the interaction between both is complex and substantial. To reduce this complexity only a few environmental measures can be used and linked to the development path of the economies. Since most of the new member states and candidate countries do not have sophisticated environment accounts, some gross but robust measures need to be used.

We propose to differentiate between input and output measures relevant for the environment. On the input side we will establish a functional relationship between energy intensity and technological development. Since the Structural Funds change the supply side of the economy and foster technological progress, it is possible to factor externalities into this relationship to show how the Structural Funds influence energy intensity.

On the output side we investigate the relationship of economic development and the level of pollution from characteristic sources. Since the main aim of the Structural Funds is to foster the economic development of the beneficiary economy in terms of income per capita a good starting point for looking at the connection between growth and the environment is the environmental "Kuznets curve", which states that the relationship between income per capita and certain kinds of pollution is roughly shaped as an inverted U. The World Bank (1992) and Grossman and Krueger (1995) first brought this empirical finding to public attention (see Frankel and Rose 2002). It was found that economic growth is associated with increased air and water pollution at the initial stages of industrialization, but as countries become more wealthy, the association becomes negative (i.e., higher growth is associated with less pollution).

The standard theoretical rationale for this general finding is that production technology makes some pollution inevitable, but that demand for environmental quality rises with income. Of course, this characterisation of the "Kuznets curve", claiming that if countries promote growth, the environment will eventually take care of itself, is incomplete, since most pollution has public good characteristics. Pure reliance on growth would result in a sub-optimal outcome, so there must also be effective government regulation

As with the energy intensity, we set up a relationship between a few crucial pollution measures and income per capita (growth). If the Structural Funds promote growth and a relationship exists, we are able to show how pollution is changed by cohesion policy. The interesting contrast will obviously be between the existing cohesion states (on the one hand) and the joining states (on the other), since it is possible that these groups may lie on different sides of the "Kuznets curve".

In addition to the above, modelling should take into account the information available about the planned environmental investments in the new member states to comply with EU environmental legislation. It can be assumed that these investments, amounting annually to 0.5-0.1% of the GDP up to 2015, would contribute to the improvement of the environment (although not necessarily an equal degree of all key environmental indicators). These investments will be all the more important for our modelling exercise if the EU's cohesion policy continues its support in the period 2007-2013 period.

8.2 Modelling environmental impacts

Two datasets are used that contain data on the environment (greenhouse gases) and the energy intensity of the economies under inspection, i.e. there are data for all cohesion and accession countries over the period 1991 to 2001 (see the appendix to this section). The data source is Eurostat.

The appendix (table A.1) shows an index of greenhouse gases for the period 1991 to 2001 and a projection up to 2010, following from the Kyoto protocol. Since the Kyoto protocol projects a linear development for the period between 2001 and 2010, it is straightforward to project the interim values. Table A.2 contains of Energy intensity measured as Gross Inland Consumption in kilograms of oil equivalent expressed as a ratio to GDP. The exact definition of both indices is also given in the appendix.

8.2.1 Pollution issues

With this data at hand, some preliminary analysis can be made. The economic literature on pollution focuses on at least two points.

The first point is that there is some empirical evidence that the relationship between the environment and economic performance has an inverse U-shape. This means that countries at different economic stages perform differently. Figure 8.1 and 8.2 show the greenhouse gases output between 1991 and 2001 for different countries. The first graph (Figure 8.1) shows the development in high income countries, and demonstrates that in all countries during the nineties greenhouse gas reduction was observed and that further reductions are expected (projected) for the period up to 2010. These countries could be viewed as being on the "right hand side" of the inverse U curve. The second graph (Figure 8.2) plots the development of the cohesion countries. During the nineties a strong increase in greenhouse gases is apparent, i.e. during this period of convergence, pollution increased. These countries could be viewed as lying on the "left hand side" of the inverse U. But the projections for the cohesion countries up to 2010 show a strong decline. This suggests that they have shifted over to the "right hand side" from 2002 onwards, or that political decisions will enforce a reduction in greenhouse gases.

The second point applies to the accession countries. Figure 8.2 shows their greenhouse gases emissions. During the nineties we observe slightly decreasing trends, because of the closing of old plants that were harmful for the environment and the basic post-liberalisation restructuring of the economy, i.e., the change from heavy industry to services (Blanchard, 1997). So these data for the period up to 2001 do not contain information that could be used to predict the development for the next decade.

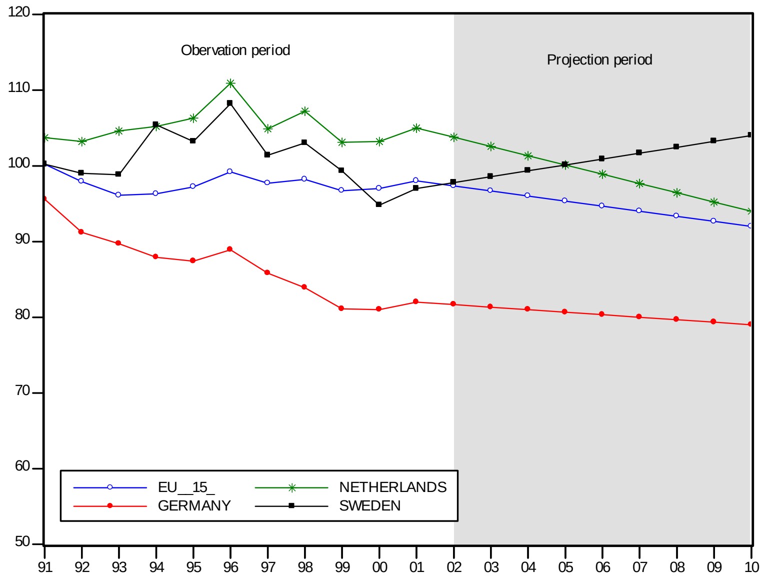
But following the projections of the Kyoto protocol, increases in greenhouse gases are expected for nearly all of these countries. Exceptions are Hungary and Slovenia, countries that (beside the Czech Republic) have the highest income per capita among the Central and East European new member states and accession countries. Therefore we suggest that *it is reasonable to use the average greenhouse gas emissions relationship for the Cohesion countries during the nineties as a proxy for the accession countries and the period 2007 to 2013*.

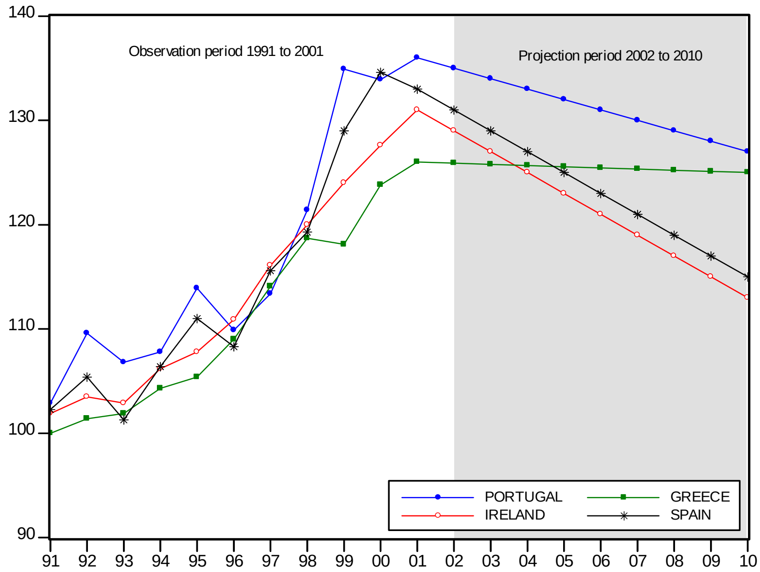
Such an approach has two advantages: first, we pick up the political projections of the Kyoto protocol; second, we have some crude economic relationship that allows us to model the impact of the Structural Funds, i.e. higher growth rates boost greenhouse gases, but higher income per capita may lead to earlier point in time where the new member states and the candidate states are likely to switch from the left hand side of the inverse U-curve to the right hand side.

In summary, if the transitional restructuring in the CEE region is now complete, and the old polluting plants of the centrally planned era are gone, then it is very likely that the new member states from the CEE region will follow the pattern of greenhouse gas emission levels that was observed in the “old” cohesion countries (Greece, Ireland, Portugal and Spain: left-hand side of Figure 8.1). But the *CP/CF* programmes are likely to accelerate the switch to the right-hand side of the inverse U-curve, after which emissions will decline as the economy grows further (right-hand side of Figure 8.1). So, in the implementation phase (2007-2013) the *CP/CF* programmes may, paradoxically, increase pollution levels, but in the post-*CP/CF* period, the longer term consequences are likely to be emission reducing.

Figure 8.1

Greenhouse Gas emissions in high income and cohesion countries: 1991 to 2001 (with linear projections to 2010 following the Kyoto protocol)

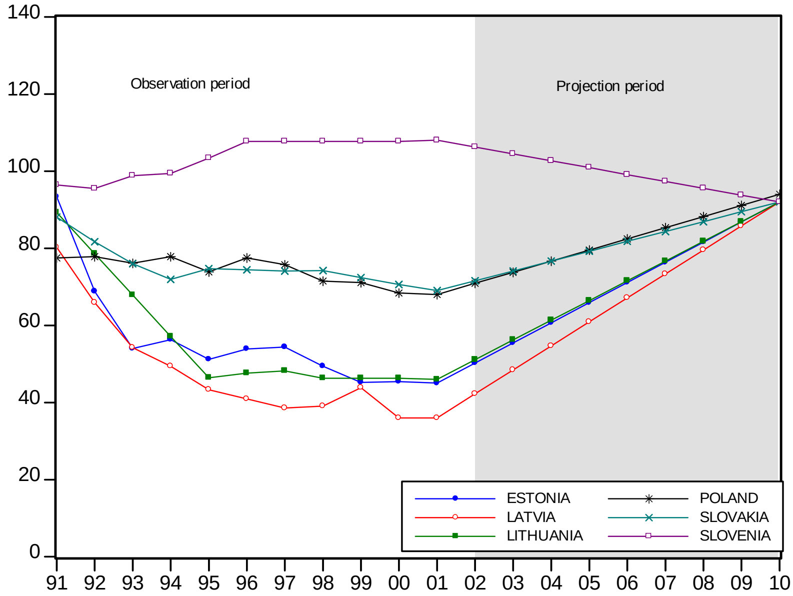


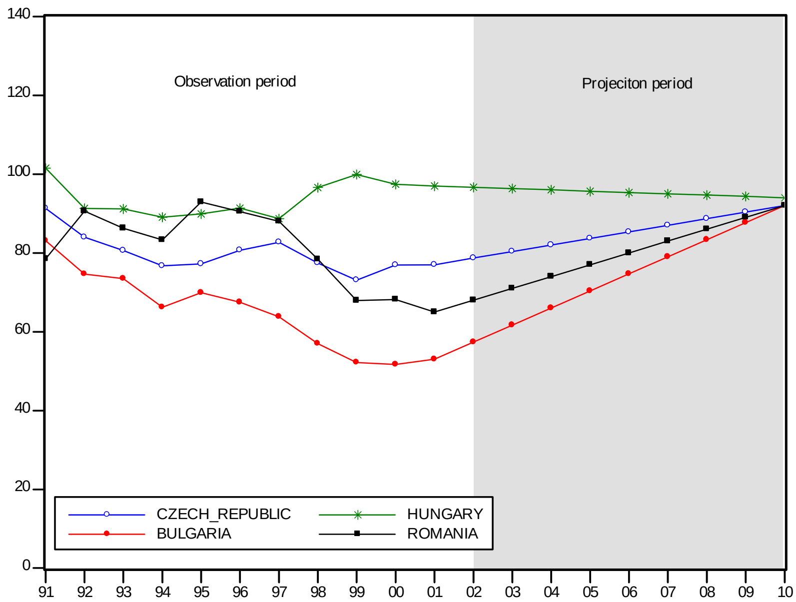


Source: see Appendix

Figure 8.2

Greenhouse Gas emissions in the accession countries: 1991 to 2001 (with linear projections to 2010 following the Kyoto protocol)





Source: see Appendix

8.2.2 Energy Demand

Energy demand functions are a subject of interest since the 1960s, and a huge number of studies have been carried out. In most empirical investigations GDP and the relative price of energy have been used as explanatory variables for energy demand, and different estimation methods have been applied. Some representative results are shown at the end of this section for the log-linear specification of the energy demand equation, an often used relationship. The conclusions that follow from these studies can be summarized as follows:

It is hard to reach a consensus on the magnitude of the various energy demand elasticities. However,

i. In general there tend to be low values for the price elasticities in both the short run and long run.

ii. In general, there is a tendency for the long-run demand elasticities to cluster around unity, where GDP is the main demand determinant..

Before looking at the impact of the Structural Funds on energy demand, we first take a closer look at the data to hand. The data come from Eurostat and measure energy demand in quantity units as a ratio to GDP (refer to Table A.2 in the appendix). The data cover all new and old member states and show therefore energy demand for all countries on a comparable base.

Our main hypothesis is that total energy demand has a long-run elasticity with respect to GDP of about unity, but energy intensity declines with higher income per capita. Consequently, if the Structural Funds enhance growth in income, then the energy intensity of GDP should decline.

Looking at data shown in Figure 8.3 shows that for the EU as a whole the energy intensity of GDP declined during the whole of the 1990s. This holds for the EU-25, the EU-15 or the euro-zone, and pronounced differences are not observable for the different aggregates. If we inspect the second graph in figure 8.3, which shows the energy intensity for the Cohesion countries, a quite different picture emerges. Three out of four countries show slight increases in energy intensity whereas Ireland reduces its energy intensity quite strongly and is well below the EU-15 average by the year 2001. On the other hand, Spain, Portugal and Greece show higher energy intensity than the EU-15 average.[62]

[62] The case of Ireland shows that the nature of industrial modernisation matters. Light industry, in the electronics and pharmaceutical sectors, is likely to be much less energy intensive that heavy industry such a motor car manufacturing and textiles. The former are characteristic of the Irish development process. The latter are more characteristic of Portugal and Spain.

Finally, Figure 8.4 shows the development in energy intensity for the new member and candidate countries. *On average the new member states reduce their energy intensity, mainly due to the reduction of heavy industries, but their levels are much higher than either the EU average or the level of the Cohesion countries.* It should also be noticed that the spread for the accession countries is much wider, so that the differences in energy intensity are much more pronounced.

Figure 8.3:
Energy intensity in the EU as a whole and the Cohesion countries
1991 to 2001

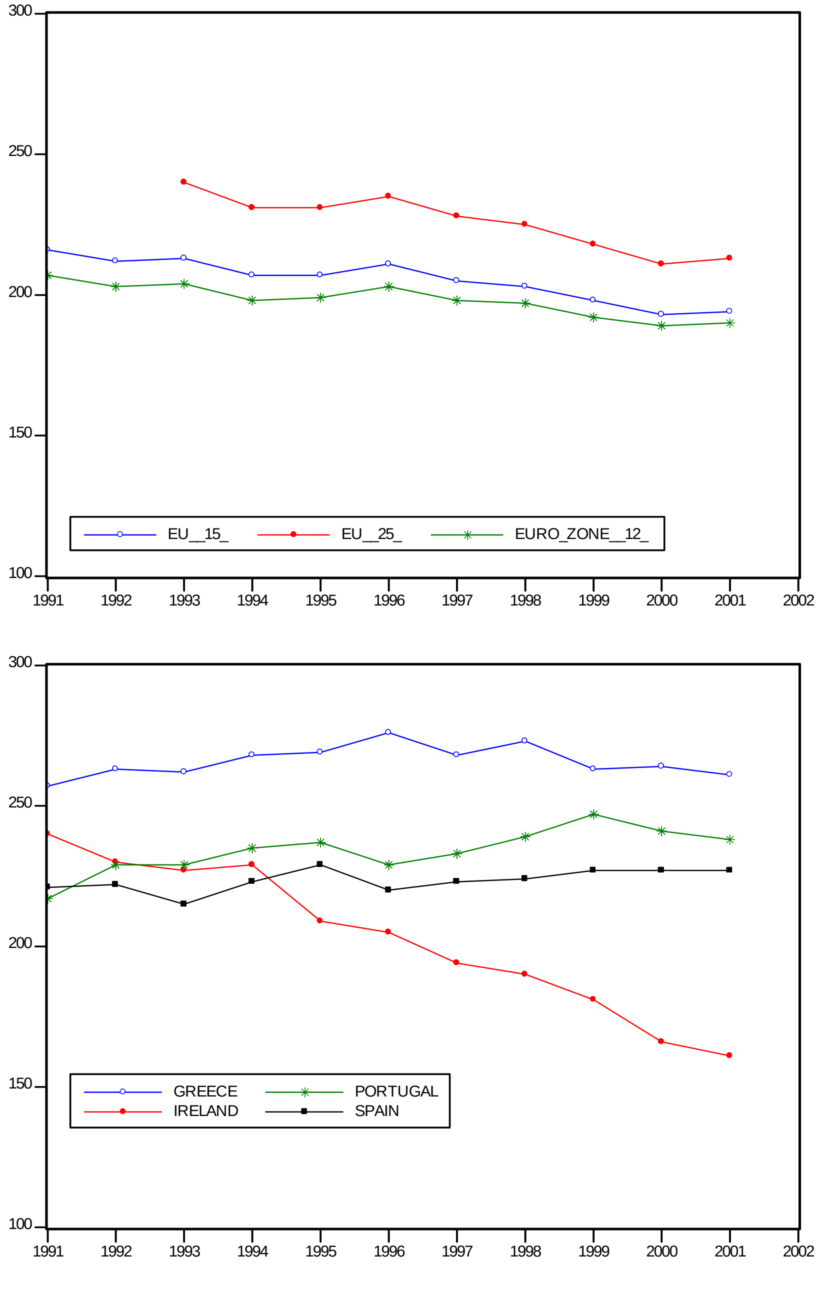
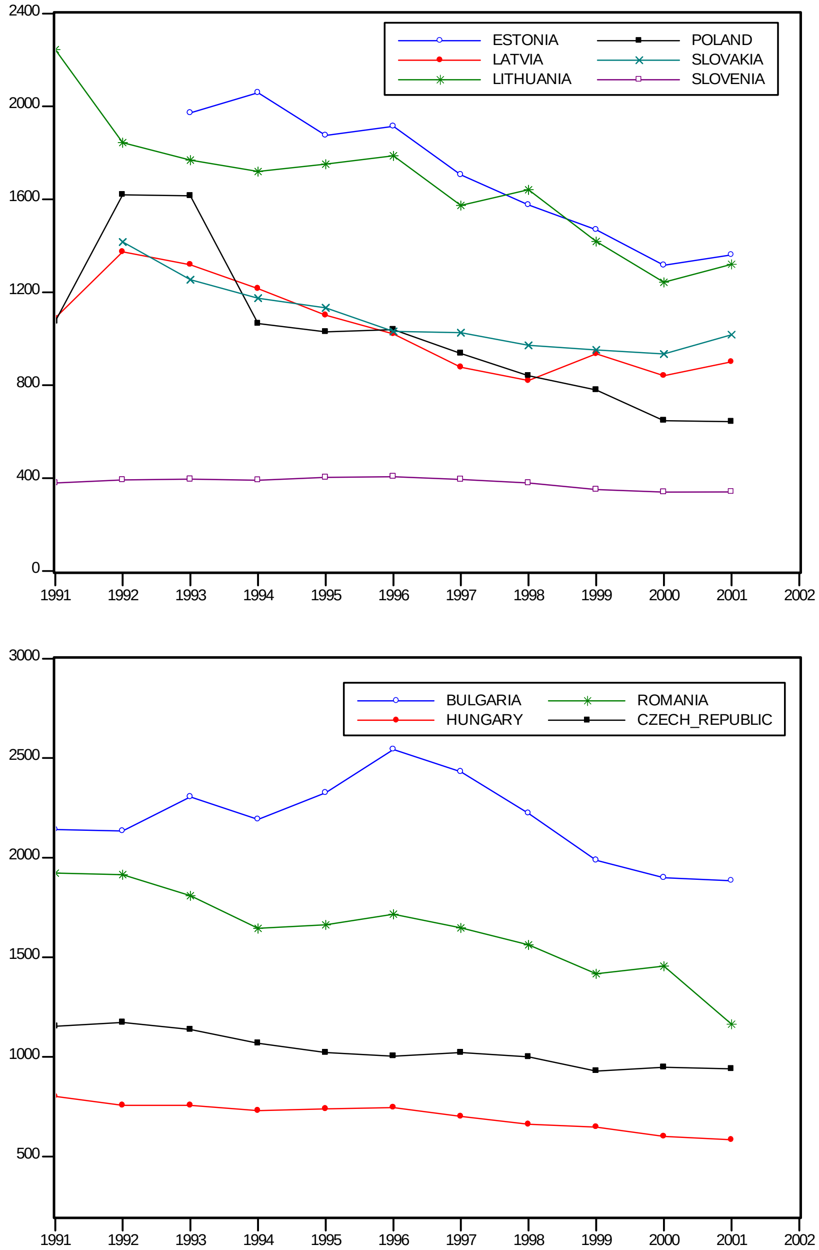
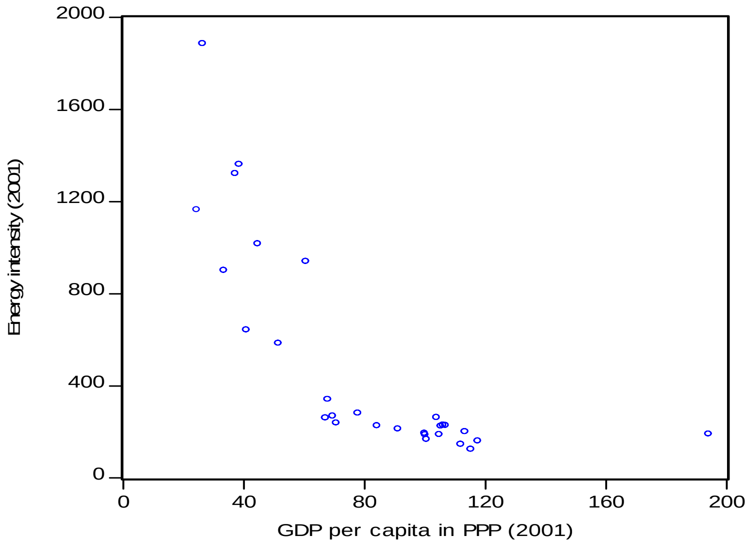


Figure 8.4:
Energy intensity for new member states: 1991 to 2001



How can these observations be linked to the Structural Fund interventions and the Convergence debate? A first impression on the relationship between income per capita (the target variable of Structural Fund interventions) and energy intensity is given by figure 8.5. It is evident that energy intensity and income are highly (negatively) correlated. *Countries with low income per capita tend to have a high energy intensity and countries with high income per capita tend to have much lower energy intensities.* Obviously the relationship between both variables is non-linear.

Figure 8.5
Energy intensity and GDP per capita in 2001



Performing a non-linear least squares regression with energy intensity as the dependent and GDP per capita and GDP per capita squared as explanatory variables, the following results are obtained:

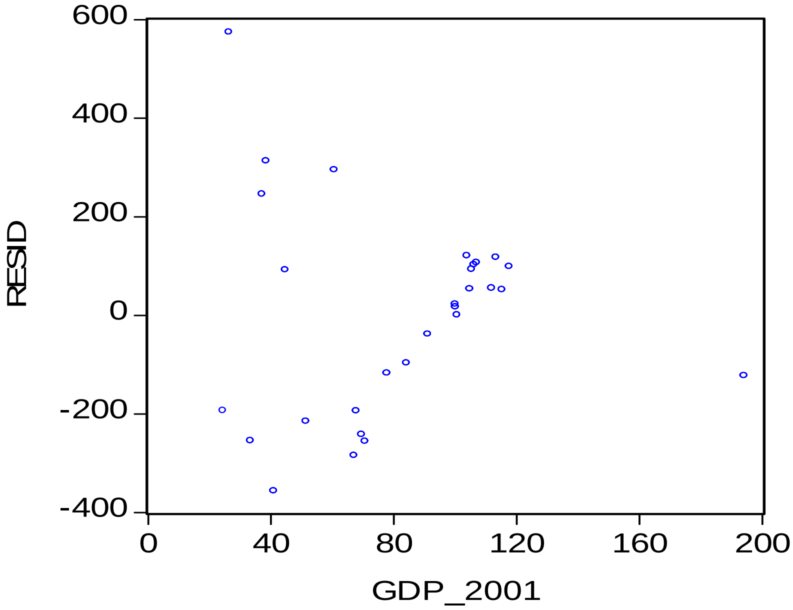
Dependent variable: energy intensity

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1986.594	165.7968	11.98210	0.0000
GDP_2001	-28.28415	3.630704	-7.790265	0.0000
GDP_2001_Q	0.101333	0.018652	5.432767	0.0000

R-squared	0.799200	Mean dependent var	488.1034
Adjusted R-squared	0.783754	S.D. dependent var	465.6520
S.E. of regression	216.5387	Akaike info criterion	13.69111
Sum squared resid	1219114.	Schwarz criterion	13.83256
Log likelihood	-195.5211	F-statistic	51.74110
Durbin-Watson stat	1.870103	Prob(F-statistic)	0.000000

About 80 per cent of the variation in energy intensity can be explained with this simple model. Furthermore the results imply a strong non-linear relationship, but there is a lot of heteroscedasticity within this cross-section as Figure 8.6 shows. The results above suggest that energy intensity is a non-linear function of GDP per capita using the national accounts for the countries under consideration and taking into account of the results given above.

Figure 8.6: Residuals



What are the implications for the *CP/CF* programmes? The analysis of Sections 5 and 6 suggest that these programmes are likely to accelerate cohesion. In some countries, this will be more rapid than in others. As income per capita increases towards EU average levels, the analysis suggests that the energy intensity of GDP will decline. The case of Ireland shows that this decline can be quite rapid, and the Irish example may turn out to be followed by the smaller CEE states like the three Baltic states and Slovenia. But the more gradual decline (or static performance) of Greece, Portugal and Spain is likely to be followed by the larger new member states, such as the Czech Republic, Poland and Hungary, and the candidate states (Romania and Bulgaria).

Appendix S8 Data on the environment

a) Greenhouse gas emissions (table A.1)

Definition:

Aggregated emissions of 6 main greenhouse gases expressed in CO2 equivalents. Emission reduction targets for 2008-2012 are those agreed upon in Council Decision 2002/358/EC (for EU countries) or in the Kyoto protocol (all other countries)

Metadata provided by Eurostat in conformity with the Special Data Dissemination Standard (SDDS).

Latest Update: July 2003

Source: http://europa.eu.int/comm/eurostat/structuralindicators

b) Energy intensity (table A.2)

Definition:

The Gross Inland Consumption of Energy is calculated as the sum of the Gross Inland Consumption of the five types of energy: coal, electricity, oil, natural gas and renewable energy sources. In addition, each of these figures is calculated as an aggregation of different data on production, storage, trade (imports/exports) and consumption/use of energy.

The **energy intensity ratio** is the result of dividing the Gross Inland Consumption by the GDP. Since Gross Inland Consumption is measured in kgoe (kilogram of oil equivalent) and GDP in 1000 EUR, this ratio is measured in kgoe per 1000 EUR

The GDP figures are taken at constant prices, base year 1995 (ESA95)

Latest Update: February 2003

Source: http://europa.eu.int/comm/eurostat/structuralindicators

Table A.1. Greenhouse Gas Emissions 1991 to 2001, Projection up to 2010. Source: see above

Country	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	*2010*
EU (15 countries)	100.2	97.9	96.1	96.3	97.2	99.2	97.7	98.2	96.7	97.0	98.0	*92.0*
Belgium	104.2	103.1	102.0	104.5	107.5	109.2	105.7	108.6	106.3	106.2	106.0	*92.5*
Czech Republic	91.3	84.0	80.6	76.7	77.2	80.7	82.7	77.4	73.1	76.9	77.0	*92.0*
Denmark	115.4	106.1	110.1	115.6	111.7	131.2	116.9	109.5	105.1	98.5	100.0	*79.0*
Germany	95.6	91.2	89.7	87.9	87.4	88.9	85.8	83.9	81.1	81.0	82.0	*79.0*
Estonia	93.3	68.8	54.0	56.3	51.2	53.9	54.4	49.4	45.2	45.4	45.0	*92.0*
Greece	100.0	101.4	101.9	104.3	105.4	109.0	114.1	118.7	118.1	123.8	126.0	*125.0*
Spain	102.3	105.4	101.3	106.4	111.0	108.3	115.6	119.3	129.0	134.6	133.0	*115.0*
France	104.1	102.3	98.5	97.9	99.5	102.3	101.0	103.8	100.6	99.5	100.0	*100.0*
Ireland	101.9	103.5	102.9	106.2	107.8	110.9	116.1	120.0	124.0	127.6	131.0	*113.0*
Italy	100.3	99.8	97.9	96.8	102.3	101.2	102.5	104.7	105.9	106.9	107.0	*93.5*
Cyprus	102.1	113.5	119.7	120.2	120.2	126.4	127.9	137.6	143.1	149.9	150.0	*:*
Latvia	80.2	65.9	54.2	49.4	43.3	40.9	38.6	39.1	43.8	36.0	36.0	*92.0*
Lithuania	89.3	78.6	67.9	57.1	46.4	47.6	48.2	46.3	46.3	46.3	46.0	*92.0*
Luxembourg	96.1	94.7	97.4	94.2	71.6	72.1	62.9	54.4	55.4	55.1	56.0	*72.0*
Hungary	101.5	91.3	91.2	89.1	89.9	91.4	88.7	96.6	99.9	97.4	97.0	*94.0*
Malta	107.9	115.3	117.8	120.5	122.3	123.3	119.7	121.6	125.5	128.5	129.0	*:*
Netherlands	103.7	103.2	104.6	105.2	106.3	110.9	104.9	107.2	103.1	103.2	105.0	*94.0*
Austria	105.3	96.4	98.1	99.6	103.5	108.4	107.8	107.4	105.2	105.0	110.0	*87.0*
Poland	77.5	77.8	76.1	77.8	73.9	77.5	75.7	71.5	71.1	68.4	68.0	*94.0*
Portugal	102.9	109.6	106.8	107.8	113.9	109.9	113.4	121.4	134.9	133.9	136.0	*127.0*
Slovenia	96.4	95.5	98.8	99.4	103.4	107.7	107.7	107.7	107.7	107.7	108.0	*92.0*
Slovakia	88.1	81.7	76.0	71.9	74.7	74.4	74.1	74.2	72.4	70.6	69.0	*92.0*
Finland	97.5	93.4	94.3	102.5	99.2	106.3	104.9	101.7	100.8	97.6	105.0	*100.0*
Sweden	100.2	99.0	98.8	105.4	103.2	108.2	101.4	103.0	99.3	94.8	97.0	*104.0*
United Kingdom	100.1	97.0	94.3	93.7	92.4	95.3	92.0	91.9	86.9	87.2	88.0	*87.5*
Bulgaria	83.1	74.6	73.5	66.2	69.9	67.5	63.8	57.0	52.2	51.7	53.0	*92.0*
Romania	78.5	90.6	86.3	83.3	92.9	90.5	88.0	78.4	67.9	68.2	65.0	*92.0*

Table A.2. Energy Intensity 1991 to 2001, Source: see above, (p) provisional data

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
EU (25 countries)			240	231	231	235	228	225	218	211 (p)	213 (p)
EU (15 countries)	216	212	213	207	207	211	205	203	198	193	194 (p)
Euro-zone (12 countries)	207	203	204	198	199	203	198	197	192	189	190 (p)
Belgium	249	249	244	241	239	252	249	249	244	236	228
Czech Republic	1154	1173	1137	1068	1022	1004	1021	1000	928	948	940
Denmark	153	146	159	152	148	162	146	141	132	125	125
Germany	194	186	188	182	179	184	180	176	169	165	168 (p)
Estonia	:	:	1972	2059	1875	1914	1706	1576	1469	1316	1361
Greece	257	263	262	268	269	276	268	273	263	264	261
Spain	221	222	215	223	229	220	223	224	227	227	227 (p)
France	207	202	206	194	198	207	199	198	192	188	189
Ireland	240	230	227	229	209	205	194	190	181	166	161
Italy	196	197	196	189	194	192	190	194	194	190	188 (p)
Cyprus	287	303	310	334	285	301	287	307	290	292	282
Latvia	1089	1374	1318	1216	1101	1021	878	820	935	841 (p)	901
Lithuania	2245	1844	1769	1720	1752	1788	1574	1641	1419	1243	1321
Luxembourg	305	301	293	275	241	238	217	198	193	186	191
Hungary	801	757	757	730	739	746	701	662	648	600	584
Malta	298	292	337	310	320	340	342	348	332	303	269
Netherlands	239	234	236	229	231	233	221	212	202	198	201 (p)
Austria	156	146	147	142	146	154	151	149	144	138	146
Poland	1075	1619	1615	1065	1029	1039	937	841	779	647	643
Portugal	217	229	229	235	237	229	233	239	247	241	238
Slovenia	379	392	396	391	403	406	394	379	351	340	341
Slovakia	:	1416	1254	1174	1133	1032	1026	972	952	934	1017
Finland	299	299	313	319	290	302	299	289	276	261	263
Sweden	276	267	266	272	265	268	255	248	238	215	229
United Kingdom	273	273	270	259	252	256	242	243	234	228	225
Bulgaria	2142	2134	2306	2192	2326	2544	2432	2223	1987	1900	1885
Romania	1923	1915	1810	1645	1663	1717	1648	1563	1418	1455	1164

Appendix B: Energy Demand Elasticities

$$Y = a_1 + a_2 \text{ Price} + a_3 \text{ Income (or GDP)} + u$$

Author (Year)	Short-run		Long-run		Sample	Notes
	Price	*Income*	*Price*	*Income*		
Field / Grebenstein (1980)			-064 to -1,65		1971 US manufacturing	Cross-section data,
Fiebig et al. (1987)			-0,66 to -0,88	1,24 to 1,64	?? 30 nations	Cross-section data
Pindyck (1979)			-1,00 to -1,25 (a) -1,7 (b) -0,22 to -1,17 (c) -0,41 - -2,34 (d) -1 ,31 (e)			Cross-section OECD countries, Different sectors (a) residential, liquid fuel (b) residential, natural gas (c) Industry, oil (d) Industry, gas (e) Transport, gasoline
Kouris (1983)	-0,15	1,08	-0,43			Time series, OECD, 1961-81
Prosser (1985)	-0,22		-0,40	1,02		Time series, OECD, 1960-82
Bentzen / Engsted (1983)	-0,14	0,67	-0,47	1,21	Denmark	Time series, ??
Hunt / Manning (1989)	-0,08	0,80	-0,30	0,35	UK	Time series,??
Balestra / Nerlove (1966)			-0,63	0,62		Panel, ?? US, States

Author (Year)	Short-run		Long-run		Sample	Notes
	Price	*Income*	*Price*	*Income*		
Kouris (1967)			-0,77	0,84	Eight nations	Panel, ??
Nordhaus (1977)	-0,03 to -0,68	0,29 to 1,11	-1,94 to 1,45	0,26 to 1,42	Seven nations	Panel,??
Hesse / Tarka (1986)			0,31 to -0,35 (a) 0,14 to -0,49 (b)		Nine nations	Panel; 1960-80 (a) before (b) after oil price shock in 1973
Liu (2004)	-0,013 (a) -0,067 (b) 0,162 (c) 0,043 (d) -0,094 (e) -0,167 (f)	0,300 (a) 0,376 (b) 1,155 (c) 0,529 (d) 0,425 (e) -0,084 (f)	-0,044 (a) -0,243 (b) 0,589 (c) 0,127 (d) -0,268 (e) -0,516 (f)	1,035 (a) 1,363 (b) 4,203 (c) 1,557 (d) 1,207 (e) -0,260 (f)	OECD	Panel, 1978-99 Industrial Sector a) Electricity b) Natural Gas c) Hard Coal d) Gas Oil e) Auto, diesel f) Heavy fuel
Liu (2004)	-0,030 (a) -0,102 (b) 0,000 (c) 0,143 (d) -0,191 (e)	0,058 (a) 0,137 (b) -1,148 (c) 0,030 (d) 0,196 (e)	-0,157 (a) -0,364 (b) 0,001 (c) -0,318 (d) -0,600 (e)	0,303 (a) 0,490 (b) -2,243 (c) 0,066 (d) 0,614 (e)	OECD	Panel, 1978-99 Residential Sector a) Electricity b) Natural Gas c) Hard Coal d) Gas Oil e) Motor, gas

[9] Summary and conclusions

9.1 Introduction

In this report we have used a series of different HERMIN country and regional models to evaluate the impact of *CP/CF 2007*-2013 on the cohesion performance of recipient countries and regions. The ideal way to carry out such an evaluation would be to have a single EU-wide model that distinguished the *CP/CF* recipient economies from among all other EU member states and regions of member states. In such an idealised situation we would simply examine the path of each of the *CP/CF* recipient economies as they evolved over time both with and without the aid of Structural Funds and would be able to address such questions as:

i. What is the precise impact of *CP/CF 2007-13* on the cohesion objective for each of the recipient economies, i.e., on the GDP per head in the recipient economy relative to the continually evolving EU average?

ii. If the *CP/CF* transfers have to be funded by transfers from the wealthier EU member states, what effect does the higher rate of taxation have on the donor country performance?

Unfortunately we do not have any such idealised model and have to do with HERMIN models that operate in stand-alone mode, i.e., in a situation where the world outside the particular recipient economy being studied is not modelled, but is assumed to be exogenous. This is not such a serious assumption, since the recipient economies are very much smaller than the other wealthier member states. For example, Estonia can be assumed to be "post-recursive" to the rest of the EU, in the sense that events outside Estonia will have a big influence on Estonia, but the Estonian economy is so small that it will have little or no reverse influence on the rest of the EU. This assumption of post-recursivity is less plausible in the case of Poland, for example, but is not completely unrealistic.

But a more serious consequence of not having an integrated EU model is that we are only able to quantify the difference between a national scenario where the *CP/CF* is in operation and one where the *CP/CF* is absent. We have seen in Sections 5 and 6 above that the *CP/CF* impact measured in this way is positive, but the cohesion objective might still deteriorate rather than improve if the other countries were growing even faster than the recipient economy.

In our summary and conclusions we focus on three aspects of the analysis: the question of how the details of *CP/CF 2007-13* were captured in the model simulations; the actual results, and what they tell us about the effectiveness of implementation of *CP/CF 2007-13*; and the critiques of macromodel-based analysis of Structural Funds that have been made recently, particularly in two reports produced by the Dutch CPB (Ederveen *et al*, 2002 (a) and (b)). We follow with some brief recommendations.

9.2 Capturing *CP/CF 2007-13* in the model

We have analysed the impacts of *CP/CF* public investment programmes implemented in the period 2007-2003, based on the crucial assumption that the actual investment expenditures (that will take place on the ground during the years 2007-2013) follow the *ex-ante* hypothetical financial allocations being used by DG-REGIO for planning purposes. This requires a sudden build-up in the year 2007, when for most countries, *CP/CF* expenditures go from zero to about one seventh of the total (since the expenditures are fairly evenly spread over the seven year period). However, over the course of *CP/CF* implementation the actual expenditures can differ from the planned expenditures, as well as from the planned financial allocations, mainly with respect to timing. And, of course, the assumption of an abrupt cessation of *CP/CF* expenditures after the year 2013 is probably very unrealistic.

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

The only way of avoiding this crude assumption of the equivalence of financial allocations and actual investment expenditures would be if the actual investment expenditures were monitored alongside the financial allocations. There are strong arguments in favour of attempting to monitor the "real" investment activities, since they are what feed into higher transitional growth.

9.3 The HERMIN Structural Fund impacts

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

However welcome the transient demand-side impacts of the *CP/CF* are, i.e., the impacts that accompany the implementation stage, it is the longer term enduring impacts that are most important. These have been captured by the externality mechanisms that are described in Section 4, and are driven by the *CP/CF*-induced increase in the stock of physical infrastructure and human capital. We have described how we selected externality elasticities from the international literature and implemented then in the HERMIN models. In Section 5 we used a standard set of elasticities common to all models, and broadly representative of the mid range of international findings.[63] In Section 6 we carried out a sensitivity analysis for each of the six models, selecting zero, medium and high elasticity values.

[63] We note that Romania is an exception, and that smaller infrastructure elasticities were used to compensate for the excessively low initial value of the stock of infrastructure (see section 5).

It is important when our numerical results are interpreted that it is understood that the *CP/CF* in the HERMIN models cannot raise the growth rate of GDP permanently. While the *CP/CF* investment expenditures are being made, and the stocks of physical infrastructure and human capital are increasing, the growth rate of GDP does indeed increase above the no-CSF baseline value. However, when the *CP/CF* terminates, the two stocks stabilize at their new (higher) values, the growth rate returns to its baseline value, but the level of GDP is at a higher value. Thus, the enduring benefit of the *CP/CF* is a semi-permanent higher level of GDP and not a permanent rise in the growth rate.[64]

In the absence of any permanent increase in the GDP growth rate, the actual impacts of *CP/CF 2007-2013* as simulated in the HERMIN models might appear quite small. We summarise the long-run impacts on the level of GDP that were derived from all models in Table 9.1 below.

Table 9.1: Increase in the level of GDP by year 2020
(% change over baseline)

	Czech Republic	**Estonia**	**Greece**	**East Germany**	**Hungary**	**Latvia**
2020	**4.4**	**3.7**	**0.3**	**0.15**	**4.1**	**1.4**
	Mezzogiorno	**Portugal**	**Poland**	**Romania**	**Spain**	**Slovenia**
2020	**0.7**	**1.7**	**2.7**	**1.7**	**0.3**	**2.08**

What this table asserts is that (say, in the case of the Czech Republic), the level of GDP in the year 2020 will be only 4.4 per cent higher than the level that it would have been in the complete absence of Structural Funds, and in the absence of any other policy changes (such as compensating domestic policy initiatives in the area of public investment). Since the "new" member states have levels of GDP per head that are between 35 and 55 per cent of the EU average, these would represent rather modest convergence steps.[65]

But we also saw that the "cumulative multiplier was a better measure of *CP/*CF impacts in the longer term, at least in terms of "value for money". The cumulative multipliers are designed to capture the notion that Structural Fund programmes continue to yield returns in terms of extra GDP even after they have ceased. This is captured by the externality parameters, that serve to drive GDP and productivity through the higher stocks of infrastructure and human capital that the CSF programmes have produced.

The cumulative *CP/CF* multipliers for the full period 2007-2020 are shown in Table 9.2, and these are considerably larger than conventional investment multipliers, mainly due to the

[64] The stocks on physical infrastructure and human capital eventually decay due to depreciation. See Sianesi and Van Reenen, 2002, for a discussion of "level" versus "growth rate" impacts of investment in human capital.
[65] In ESRI, 1997, the HERMIN models for the three cohesion countries and Spain were used to evaluate the joint impact of the Structural Funds and the Single European Market initiative of 1992. This is probably a better way to investigate the role of Structural Funds, i.e., to examine their "facilitating" role in integrating the poorer countries into the European market, and to stimulate inward investment.

long-tailed output and productivity-enhancing effects induced by the higher stocks of physical infrastructure and human capital that are brought about by the *CP/CF* programmes.

Table 9.2: *CP/CF*: Cumulative multipliers

	Czech Republic	Estonia	Greece	East Germany	Hungary	Latvia
2007-2020	2.8	2.4	0.9	1.2	1.6	1.8
	Mezzogiorno	Portugal	Poland	Romania	Spain	Slovenia
2007-2020	1.1	2.0	2.4	1.8	1.7	2.5

9.4 Critiques and alternative approaches

The term "cohesion" first came into widespread use in the European Union in the late 1980s, at a time when major reforms and expansions of EU regional aid were being carried out. As set out in Article 130a of the Treaty on European Union, there is an explicit aim to promote "harmonious development" with a specific geographical dimension: "reducing disparities between the levels of development of the various regions and the backwardness of the least favoured regions". Thus, there is an explicit recognition that wide disparities are intolerable in any community, if that term is to have any real meaning.

Conventional (or neoclassical) economics – particularly in its New Classical revival in the 1970s - had asserted that market based capitalism was a universal path towards development that was potentially available to all countries. Within the universally dominant paradigm of liberal market economics, it was widely believed that no underdeveloped country was likely to remain disadvantaged permanently simply because it was late coming to the growth process. Nor could the established industrial powers block the development of a latecomer, provided that country played by the rules of economic liberalism. Any remaining failure by a state to grow and prosper was deemed to be self inflicted (Fukayama, 1992, p.103).

This crude version of what tends to be called the *Anglo-Saxon* policy model takes the view that all one has to do to promote real convergence (or "cohesion") between groups of states is to put in place policies that facilitate the free movement of goods and the factors of production (i.e., labour and capital).[66] If this is done, then orthodox theory asserts that factor incomes (wages as well as the returns on capital) will tend to converge to a common level across all nations in the group. So, if all markets are competitive, any initial national disparities will eventually vanish and there would be no need for specific structural regional policies.

By the late 1980s, when the EU began to get serious about trans-EU regional development policies, the intellectual ground had begun to shift under the *Anglo-Saxon* model. Over the past two decades, three fields of economic research have undergone radical transformation: trade theory (Helpman and Krugman, 1985), growth theory (Grossman and Helpman, 1991), and economic geography (Fujitsa, Krugman and Venables, 1999). Advances in the study of

[66] Real convergence (or cohesion) requires convergence in living standards. Nominal convergence requires convergence of inflation rates, interest rates, and public sector balances.

spatial economic processes suggested that the conditions required for automatic convergence to take place tend not to hold in practice (Krugman, 1995, p. 82). Rather, research attention began to be focused on the importance of such factors as the initial level of regional physical infrastructure, local levels of human capital, or on the fact that regions that start off at a structural disadvantage may never converge in any reasonable time period. Research even suggested that the removal of barriers to trade and factor movements might – in certain circumstances - actually lead to a relative deterioration rather than an improvement of some countries (Williamson, 1965; Krugman, 1987).

This was the intellectual background against which the EU reformed and expanded its regional policies in the late 1980s, into the so-called *National Development Plans* and their associated *Structural Funds*. The political rationale behind this reform came from the programme of market liberalization (or Single Market initiative of the then EC President, Jacques Delors), which dismantled all remaining non-tariff barriers within the Union (Cecchini, 1988). In doing so, there was a fear that not all EU member states were likely to benefit equally from the Single Market,. In particular, the less advanced, geographically peripheral economies of the southern and western Europe (mainly Greece, Portugal, Spain and Ireland, but including the Italian *Mezzogiorno* and - after unification - East Germany) were felt to be particularly vulnerable. Today, it is the new member states of Central and Eastern Europe – almost all of which have levels of income per head less than half of the EU average - which may be at risk.

What was special about the Structural Fund policies was their ambitious goals, i.e., the provision of financial aid (in the context of a domestic co-finance requirement) to implement policies whose explicit aim was to transform the underlying structure of the beneficiary economies. Policies moved far beyond a conventional demand-side, cyclical stabilisation role of public expenditure, and were directed at the promotion of structural change, the acceleration of medium-term growth, and the eventual achievement of real convergence mainly through efficiency improvements in supply-side processes. The main policies targeted concerned the improvement of basic physical infrastructure, the enhancement of human capital, and certain targeted aids to the private productive sectors

The long-term nature of the EU investment aid – up to seven years – permitted domestic public investment policies to shift from a purely domestic process, buffeted by the short-term exigencies of maintaining balance in the public finances, to a more stable longer-term process that was carried out in co-operation with the European Commission. The ceding of some national policy autonomy to the Commission in Brussels seems to have generated minimal friction since the whole Structural Fund process was perceived to be a genuine partnership that allowed successive political administrations to break with the previous process of annual capital budgeting and put in place development plans of much longer duration, to finance them with far less difficulty in terms of increased public sector borrowing or taxation, and to benefit from trans-EU shared experiences in policy design, monitoring and evaluation..

Strict monitoring systems are mandatory for the Structural Funds, as well as the need to carry out *ex-ante*, mid-term and *ex-post* policy evaluations (Bradley, 2001). Previous evaluation of public investment programmes had at best been secretive, and at worst of very mediocre quality. The monitoring and evaluation aspects of Structural Funds served to promote and guide applied economic research agendas in Ireland and in Southern Europe since 1989, and are now doing so in the new member states.

There may well be convinced believers in the *Anglo-Saxon* model, who assert that Structural Funds are a distortion of market forces, and that the provision of physical infrastructure and human capital should be left to market forces. But this type of ideological critique tends to be rare in Europe, at least among economists. The critiques that are advanced tend to be more subtle. Basically, they assert that Structural Funds – however well intentioned and necessary - produce no significant beneficial effects.

Such a critique has been advanced recently in two papers published by the Dutch CPB (Ederveen *et al*, 2002a and b). They make the perfectly valid point that when macro models are used to evaluate Structural Fund impacts on cohesion, they tend not seek to establish if there is a positive impact on the cohesion objective due to the policies. Rather, they characterise model-based research on Structural Fund policy impacts as "imposing" the results.[67]

The alternative approach suggested by Ederveen *et al* (2002a and b) is to set up Barro-type growth regressions (Barro and Sala-i-Martin, 1995) and augment them with Structural Fund variables. Thus, the basic Barro-type regression will have growth of GDP as the dependent variable and the initial level of GDP per head, the domestic savings rate, population growth, etc., as independent variables. They insert the Structural Fund expenditures into such a model and seek to estimate statistically significant and positive coefficients.[68] In general they fail to find any significant Structural Fund effect. But since they examine a wide range of countries, some of which received very little aid, and deal with a time period that stretches from the mid-1960s to the early 1990s, their findings are not surprising.[69] However, when they add a "conditioning" variable (such as openness, institutional quality, corruption index, etc.), their analysis suggests that a few countries like Ireland did benefit from an increased growth rate that was associated with the Structural Funds.

We suggest that this approach suffers from the fact that it posits a model where the only Structural Fund impact looked for is one on the growth rate. In most of the sample of thirteen EU countries and for most of the sample period 1960-95, the regional aid was trivially small, and was very unlikely to affect the growth rate, even temporarily. The macro-model-based impact evaluations usually posit a less stringent "levels" effect, and draws on the international literature to support it. If the CPB approach were to be restricted to the poorer EU member states, and excluded such high income countries as Denmark, Sweden, the Netherlands, France, etc., then significant effects on growth might reasonably be sought. However, the panel regression technique requires a wide range of countries, which frustrates application of the technique to lagging countries in isolation.

Within the literature of policy impact evaluation using structural macro-models, there are also differences of emphasis. For example, the EC's own model – QUEST - is sophisticated neo-Keynsian, with forward-looking (or model consistent) expectation mechanisms. In such models one tends to get policy crowding out caused by the anticipation of tax increases in the

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[67] One line of research being critiqued by the CPB team is that of the HERMIN-based evaluations used in this report (see also Bradley *et al*, 2004(a) and (b)). But in this literature, any imposition of impacts is not arbitrary. We have shown that it draws on a large and authoritative research literature and uses impact elasticity values that are consistent with this literature.

[68] A pooled cross-section regression is used, with thirteen EU countries in the data set and using seven five-year periods from 1960-65 through 1990-95.

[69] It should be noted that the level of Structural Fund investment aid was very low prior to 1989, and was only expanded massively after that.

future to pay for public investment in the present. Any impact analysis based on QUEST tends to show very small effects of Structural Funds on GDP, just as they show negligible effects of any tax-financed public expenditure.

But it is arguable if crowding out is a reasonable assumption in the lagging economies which are the main beneficiaries of EU investment aid. First, such economies tend to be operating well below full capacity. Second, the public expenditure involved is on public goods that provide direct inputs into private production processes, where the returns to the investments are almost all private, and where there are externalities involved. Third, the direct EU aid element of the Structural Funds lessens the tax burden, and revenue buoyancy offsets some of the deterioration in the public sector borrowing requirement.

But in a sense, these debates may be missing the point. They focus exclusively on an economic perspective and the debate is essentially about the rate of return on investment. With carefully designed macromodels, one can examine the difference between performance "with" Structural Funds, and performance "without".[70] We have seen in this report that such evaluations tend to give rise to relatively modest boosts to cohesion. The more *Anglo-Saxon* your model, the smaller the impact! But the policy instruments of Structural Funds (mainly physical infrastructure and human capital) provide inputs into a cohesion process, but do not guarantee it. Only if individual businesses exploit the improved economic environment will cohesion happen. This is a field of research that urgently needs to be developed.

9.5 Recommendations on methodology

We restrict our recommendations to a few matters that are related to the methodology of the analysis of *CP/CF* impacts, since individual country National Development Plans that will be prepared in the context of the 2007-2013 programme will be in a better position to discuss the details of the *CP/CF* with a view to drawing lessons.

It is important to bring together as wide a range of impact evaluation techniques as possible. This is an area where all new insights are welcome. There is an urgent need to facilitate this kind of research in the recipient countries, and in the "new" member states in particular. The MEANS programme of DG-REGIO is an obvious vehicle for this work.

The HERMIN and QUEST model-based analysis could be greatly improved if there was a programme of microeconomic or cost-benefit analysis of *CP/CF* programmes from which HERMIN and QUEST could draw. Such work could be used to guide the selection of the crucial externality elasticities for the HERMIN-based approach. It may be the case that DG Regional Policy, with its access to national studies and its oversight role, may be able to act as co-ordinator and disseminator of such research.

The construction and updating of some of the HERMIN models was severely hampered by the lack of consistent time series of data. These problems, as well as our approach to tackling them, are documented in the MS Excel files of basis input data that form part of the construction of the databases for the individual HERMIN models. In this respect the DG-

[70] By "carefully designed" we mean structural models, where policy-induced changes in structure are explicitly modelled. Such models are less susceptible to the so-called Lucas critique of reduced form time-series models (Lucas, 1969).

ECFIN internal database was invaluable. The CRONOS data, on the other hand, were riddled with inconsistencies and missing data.

Finally, the context within which sequences of National Development Plans are evaluated needs to be re-examined carefully. At present, the impact of each NDP is examined in isolation of any NDP activities that preceded it. But clearly the NDPs for any specific country or macro region are inter-related over time. Thus, CSF 1989-93 mutated into CSF 1994-99, which in turn mutated into CSF 2000-06, and looks likely to mutate further into CSF 2007-13. To analyse these CSFs in isolation from each other is unrealistic and illogical. On the other hand, there is a compelling case for carrying out CSF-type impact analysis on a "rolling" or "cumulative" basis.

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