Macro-regional evaluation of the Structural Funds using the HERMIN modelling framework

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Abstract

A particular focus of the Structural Funds is an Objective 1 regions that lag behind in terms of their GDP per capita relative to the EU average. The amount of investment that is funded through the Structural Funds by the EU is substantial and consequently EU legislation requires the appraisal of the policies undertaken. Our modelling framework - HERMIN - has been widely applied to Structural Fund analysis at the national level and macro-regional level. The HERMIN framework is based an a small open economy model. Importantly it incorporates mechanisms, which are based an the endogenous growth literature, which allow it to capture the long-run supply side impact of the Structural Funds along with the short run Keynesian impact. This paper reviews this modelling framework and shows the impact that the Structural Funds appear to have had during the 1994-1999 programming period.

Keywords: Structural Funds, Evaluation, Macro-Regional Model.

JEL-classification: E17, E65, R15, R58.

1. **Introduction**

Structural Fund (SF) interventions play a crucial role in improving the Social and economic cohesion of the EU. A particular focus of the structural funds is an "lagging" regions, where their GDP per capita is below 75 per cent of the EU average. For the purposes of allocating Structural Funds, these

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regions are classified as Objective 1 and make up a significant part of the EU. In 1999 they accounted for 25 per cent of total EU population, and in general they are poorly endowed in a number of areas, such as infrastructure, human capital, and modern high productivity industries and services. As a consequence, they tend to have higher rates of recorded and hidden unemployment and lower potential growth prospects.

The amount of investment that is funded though the SFs by the EU is substantial. For the Objective 1 regions for the period 1994 to 1999, this amounted to some € 103 billion, which was allocated to investment in 11 separate EU Member States. For the period 2000 to 2006 the financial package for structural policies allocates a total of € 213 billion, of this 195 billion are allocated to the Structural Funds and € 18 billion to the Cohesion Fund that has in large the Same intervention areas as the Structural Funds. Given the size and significance of the EU aid package, legislation in the form of the Council Regulation No. 1260 of 26.06.99 requires the appraisal of the Structural Funds as well as a regular reporting an the economic and social cohesion in the EU. However, while systematic monitoring and evaluation frameworks are available at the national level, a rigorous and systematic method for quantifying the socio-economic impacts of the interventions an regional economies has not been developed to the Same extent. One problem at the regional level is that policy-makers seldom have access to accumulated research an the macroeconomic and macro-sectoral performance at a regional (NUTS 11) level, which would allow them to assess the overall impact of the Structural Funds.

Furthermore 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 a region (the regional supply side) over the long run rather than to provide a short-run cash injection. This limits the number of potential impact evaluation methodologies since some are less capable of capturing these long-run effects.

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

While this paper is not aimed at reviewing this literature an Structural Funds evaluation, it is nevertheless important to be aware of the different types of methodologies that have been used for this purpose. These include: case studies, 1-O models, CGE models, single equation econometric models and multi-equation econometric models (see Ederveen, Gorter, de Mooij and Nahuis, 2002, for review of some of the evaluation techniques).

Beutel (2002) applies an input-output methodology to Structural Funds impact analysis at the macro-regional level (East Germany and the Italian *Mezzogiorno)* and at the national level (Greece, Ireland, Portugal and Spain). In addition to the problem of updating input-output tables, it is very difficult to incorporate supply-side (or neo-classical) adjustment mechanisms into a static input-output framework. However, the 1-O approach is ideally suited to analyse the distributional impact of the Keynesian effect which is important from a policy point of view as most governments are concerned about issues such as poverty and clearly it would not be desirable to increase poverty in response to the Structural Funds.

Another regional modelling framework is that of Treyz (1993), which has recently been extended to incorporate aspects of the new economic geography (Fan, Treyz and Treyz, 2000). However, the earlier (1993) work - although articulated at a very high level of spatial disaggregation - is based mainly an a very simple income-expenditure framework, and ignores most aspects of the supply-side adjustments that arise as a result of targeted structural fund interventions. The more recent "new geography" model (2000) provides an important first step towards incorporating the results of this new literature into policy analysis tools but is still at a highly experimental stage and may be difftcult to operationalise in the context of integrating its insights with the Body of existing European work an Structural Funds.

Among the single equation econometric evaluations of the impact of the Structural Funds, some are based an the simple growth regressions, where Structural Fund investment expenditure indicators are added to the right hand side. For example Tondl (1999) uses this type of framework using a panel of regional data. A similar approach is used by Ederveen, de Groot and Nahuis (2002).

De la Fuente and Vives (1995) study the impact of the EU Regional Development Fund (ERDF) and of public investment in infrastructure and education an 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.

Evaluation based an fully specified macroeconomic models has been carried out, e.g., Bradley et al. (1995), Roeger (1996) and Bradley, Morgenroth, Untiedt (2003). The main advantage of such model-based evaluations is that they permit one 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.

One macro-sectoral modelling framework - HERMIN - 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 and Northern Ireland)[2]. The main advantage is that at the national and macro-regional level, the HERMIN macro-sectoral framework has a proven 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).

In this paper we review the theoretical foundations of the HERMIN modelling approach, outline its application and outline the results we obtained from its application to Structural Funds evaluation. This review will highlight not only the strengths of the approach but also the weaknesses and areas for further research.

This paper is organised as follows. Chapter 2 outlines the theoretical foundations of the HERMIN model. Chapter 3 identifies the specific aspects of the Structural Funds that need to be captured in the model, and chapter 4 discusses the evaluation results of the HERMIN framework for the Structural Fund programmes for the period 1994-1999. Finally, chapter 5 summarises the paper.

2. The Structure and Theoretical Foundations of HERMIN

The basic macro-sectoral methodology appears to be an appropriate approach to develop 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.

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

(i) The model must be disaggregated into a small number of crucial sectors, which permits the identification and treatment 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 Objective 1 national or regional economy is inter-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 Objective 1 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.

2. Collaborative research is currently underway to extend the HERMIN framework to include the Italian Objective 1 Mezzogiorno region (ESRI, CRENOS and GEFRA) and the East German state Sachsen-Anhalt (GEFRA, ESRI).

(iii) The modelling framework must recognise that a possible conflict may exist between actual situation in the less developed Objective 1 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 an key structural features of an Objective 1 economy 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 macroeconometric 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[3]. 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 theee main blocks:

a supply-side (determining output, factor inputs, wages, prices, productivity, etc.);
an *absorption* side (determining the expenditure side of the national accounts such as consumption, stock changes, etc.);
an *income distribution* side (determining private and public sector income).

Conventional Keynesian mechanisms are at the core of the HERMIN model in the short tun. Thus, the interaction of **the expenditure and income distribution sub-components generate the standard multiplier properties of the HERMIN** model'. However, the model also has neoclassical features, mainly

3. 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.

4. 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

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 in the wage bargaining mechanism introduces further relative price effects.

The schematic structure of the HERMIN model is illustrated in Figure 1. The national accounts defme three ways of measuring GDP: the output basis, the expenditure basis and the income basis. Ort the output basis, HERMIN disaggregates this into four sectors: manufacturing (OT), market services (ON), agriculture (OA) and the public (or non-market) sector (OG). Ort the expenditure side, HERMIN disaggregates into five components: private consumption (CONS), public consumption (G), investment (1), stock changes (DS), and the net trade balance (NTS). National income is determined an the output side, and disaggregated into private and public sector elements.

Since all elements of output are modelled, the output-expenditure identity is used to determine the net trade surplus/deficit residually. The output-income identity is used to determine corporate profits residually. Finally, the equations in the model can be classified as behavioural or identity. In the case of the former, economic theory and calibration to the data are used to defme 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.

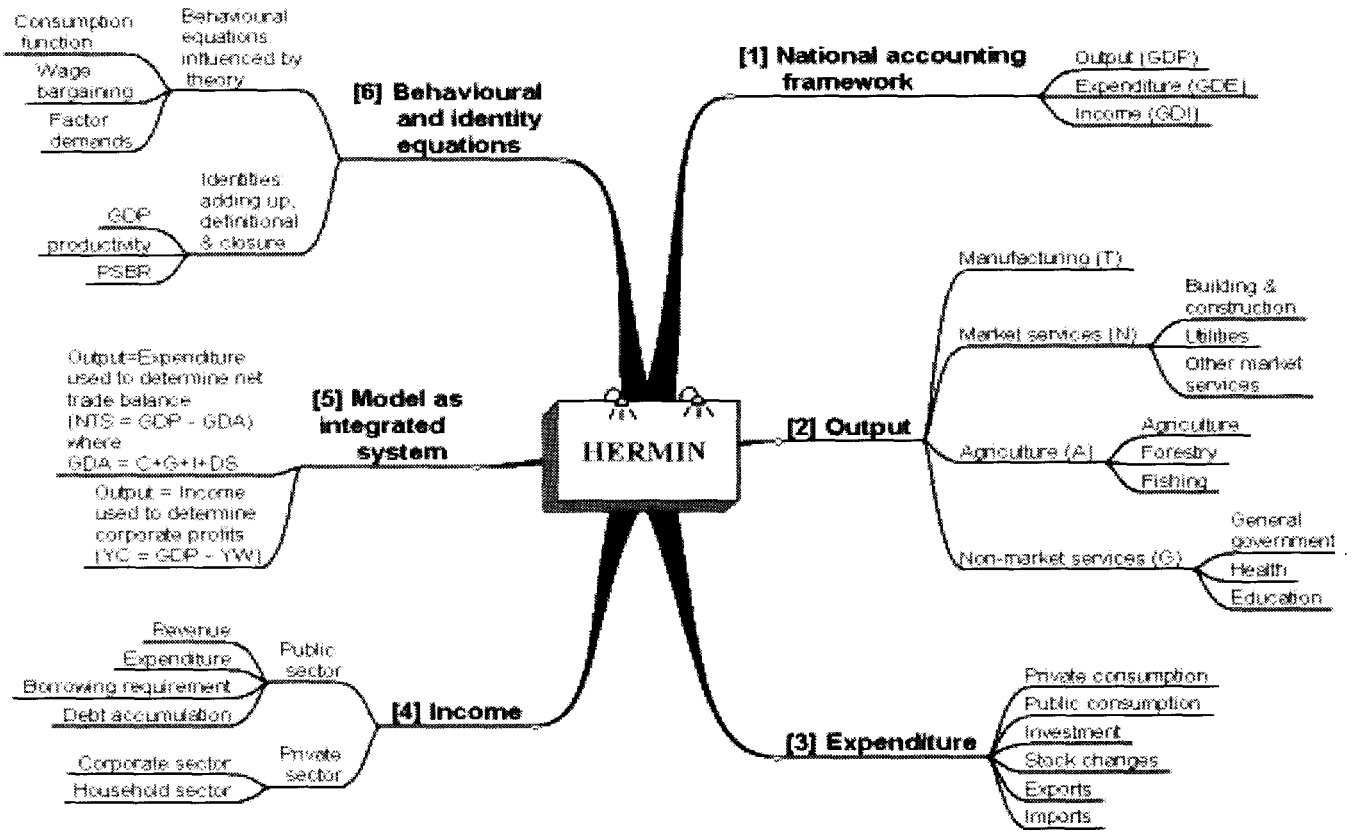
Apart from capturing the usual macroeconomic relationships, an important aspect of regional modelling is that it needs to take account of spillovers, linkages and leakages which are less important at the national level but which can have a substantial impact at the regional level. This is particularly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

For example, an investment may have an impact an 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 an the labour force by inducing migration and commuting. These type of labour market impacts have been incorporated into the existing macro-region modelss.

mainly an public goods (e.g., physical infrastructure and education/training), it might be questioned if "crowding ouP' 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).

5. The population is determined through a natural growth rate that is augmented by migration flows. These migration flows are modelled following the Standard Harris-Todaro approach

Figure 1 - Schematic outline of the HERM/N 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. The models are calibrated using time series of national accounts data from the period 1980-2000 and earlier versions are described in ESRI, 1997. 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 WINSOLUE Software package.

3. Incorporating the Impact of the Structural Funds

At the national and regional level the Structural Fund programmes consist of a multitude of individual 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 economically meaningful categories, for the following reasons. First, 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 perspective. Second, if the unit of analysis is a country or a single macro-region of a country, there is no requirement to distinguish, say, the ¡mpact of a new road in one sub-region as compared with another sub-regionb. Third, if the Structural Fund expenditures are aggregated into economically meaningful categories, orte can make use of research an the ¡mpacts of public investment an the performance of the private sector. The most useful categorisation amalgamates the measures into just three categories namely:

i. Investment expenditures an physical infrastructure
ii. Investment expenditure an human resources
iii. Expenditures an 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;

as a function of the relative expected real wage. We assume that commuting flows across national boundaries are zero and given that commuting out of Northern Ireland to the rest of the UK would involve a long sea crossing we also assume this to be zero. Thus we only incorporate a mechanism for commuting flows for East Germany where the net-commuting flows for East Germany are modelled as a fixed proportion of the labour force, which is supported by the data over the Sample period.

6. 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.

b. Domestic public sector co-financing as set out in the Structural Fund treaties',
c. Domestic private sector co-financing as set out in the Structural Fund treaties.

Inclusion of the private sector co-financing is at best problematic, and they are usually ignored in our analysis. Of course, there are indirect impacts of publicly financed Structural Fund investment an private sector investment, and these are included in the analysis. 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, they are best excluded'.

Structural Fund actions influence the Objective 1 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 modeln, 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:

increase investment in order to improve physical infrastructure as an input to private sector productive activity;
increase in human capital, due to investment in training, an input to private sector productive activity;
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 private capital stock. Providing more and better infrastructure, increasing the quality of the labour force, or providing investment aid to firms, are the mechanisms through which the Structural Funds improve the output, produc-

7. Note that "domestic" public sector co-fmance in the case of East Germany includes a large intra-German transfer from West to East, and similarly for Northern Ireland a transfer from Great Britain to Northern Ireland.

B. In the simulations carried out for the European Commission, we were usually asked to exclude all private sector co-finance, so as to identify the impact of the EU and public expenditure only.

tivity and cost competitiveness of the 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, for example in human capital or 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 qualities. These externalities have an important implication for the Jong-run impact of the Structural Funds and thus, to properly assess the impact of the Funds these must be incorporated into the modelleng 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 ferst 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 restricted context of fixed output, labour must be shed. 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 remains weak. However, an the plus side, factor productivity is driven up, real incomes rise, and these effects cause knock-on multiplier and other benefits throughout the economy. Thus, the role of the output externality is more unambiguously beneficial: the higher it is, the faster the period of transitional growth to a higher income plateau.

The elasticities relating the beneficial externality effects to the Structural Fund investments, particularly in relation to infrastructure, have been chosen

an the basis of an exhaustive literature review (see Bradley, Morgenroth and Untiedt, 2000, 2003 for details)[9]. 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. However, since the empirical research that yields such elasticities does not exist for many regions and some less developed countries, those for more advanced economies sometimes have to be utilised. 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 and 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. Impacts of Structural Funds

The HERMIN framework has been used extensively for Structural Fund analysis, covering both ex-ante and ex-post evaluations. Here the process of carrying out such an evaluation is outlined for the ex-post evaluation over the programming period 1994-1999[10]. The manner in which we execute this macro-sectoral impact evaluation exercise is as follows:

We carry out a model simulation starting in the year 1993 (the year before the 1994-99 Structural Funds programme was implemented), and continue the simulation out to the year 2010, i.e., eleven years after the termination of the 1994-99 Structural Funds. For the purposes of isolating the separate impacts of the 1994-99 Structural Funds, we ignore the carry-over impacts of the previous 1989-1993 Structural Funds, as well as the continuation of Structural Funds aid after the year 1999. We then "extract" the 1994-99 Structural Funds policy shocks, i.e., we set the Structural Fund expenditures at zero and re-simulate the model"[11]. No other changes are made, and no

9. Other useful surveys of the literature can be found in Sianesi and Van Reenen, 2002, De la Fuente and Domenesh, 2002 and Sturm, Kuper and de Haan, 1996.

10. For a more detailed account of the CSF 1994-99 impact analysis, see **Bradley, Morgenroth and Untiedt** (2003).

11. 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 Structural Fund-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 Structural Funds, so the validity of the Lucas critique is weakened.

attempt is made to design a "substitute" domestically funded public investment Programme that would have replaced a "missing" 1994-99 Structural Fund Programme. This is a very artificial assumption, since in the absence of Structural Funds for the period 1994-99 there almost certainly would have been substitute domestically funded public investment Programme, albeit smaller in magnitude'2.

Ideally we should use the actual ex-post realised Structural Fund expenditures. But these were not available for every country or region". In the interests of uniformity, in this section we have used the planned Structural Funds expenditure data as contained in the 1994-99 Structural Funds treaty documents. While these give a fairly accurate total for the expenditures, they do not always give an accurate picture of the ex-post scheduling of the expenditures. This is only an important issue in the case of Greece, where the planned even spread of expenditures over the six years 1994-99 was actually implemented in a very different way. Ex-post, the Greek Structural Funds expenditures were re-programmed to the aater years.

The "without-Structural Funds" simulation results are subtracted from the "with-Structural Funds" simulation results, and this is used as a measure of the continbution of the Structural Funds. Thus, the Structural Fund impact analysis is carried out as follows:

i. We first carry out a model simulation starting in the year 1993 (the year before the 1994-99 Structural Funds were implemented), and continue the simulation out to the year 2010, i.e., eleven years after the termination of the 1994-99 Structural Funds. This simulation acts as a "with-Structural Funds" baseline, and attempts to describe the likely evolution of the economy in the presence of the Structural Funds;
ii. For the purposes of isolating the separate impacts of the 1994-99 Structural Funds, we ignore the carry-over impacts of the earlier 1989-93 programmes, as well as the continuation of Structural Funds aid after the year 1999. Any examination of the actual outturn for the period 1994-1999 will show the results of a "with-Structural Funds" policy framework. Thus, this outturn included the carry-over from previous programmes as well as the implementation of the 1994-99 Structural Funds. Consequently, a simple examination of the actual macroeconomic outturn will present a misleading impression of the likely role played by Structural Funds.
iii. The inclusion of the Structural Fund investment expenditures triggers a build up of the stock of physical infrastructure and human capital. As

12. This involves the usual assumption of quasi-linearity, which is valid for most standard macro models.

13. Complete ex-post Structural Funds 1994-99 data were only available for Northern Ireland, Portugal and Ireland.

explained earlier, this boosts output directly and also raises the level of productivity to an extent that is determined by the externality elasticities.

iv. In the "with-Structural Funds" simulation, we set the externality elasticities to a standard set of values for all four models. These are in the mid-range found in the international literature, and both the output and factor productivity elasticities are set at 0.20 (i.e., a one per cent rise in the stock of physical infrastructure or of human capital will increase the level of output and the level of factor productivity in the medium term by 0.2 per cent). We relax this assumption later when we carry out a sensitivity analysis.

v. We then "extract" the 1994-99 Structural Funds public policy shocks (i.e., EU and domestic public expenditures) from the above simulation, i.e., we set the 1994-99 Structural Funds expenditures at zero and re-simulate the model. No other changes are made, and no attempt is made to design a "substitute" domestically funded public investment programme that would have replaced "missing" Structural Funds. Again, this is a very artificial assumption, since in the absence of Structural Funds there almost certainly would have been substitute domestically funded public investment programme, albeit smaller in magnitude.

vi. The "without-Structural Funds" simulation results are subtracted from the "with-Structural Funds" simulation results, and this is used as a measure of the contribution of the Structural Funds to a range of macroeconomic targets.

While the model-based macro-economic analysis holds out the promise of quantification of Structural Fund impacts, it is important not to exaggerate the potential of this methodology. Anyone expecting a simple, single, easily derived "correct" answer to a question such as "what was the impact of the 1994-99 Structural Funds an GDP?", is likely to be disappointed. Indeed, such a question is conceptually vague and ill-posed for a number of reasons.

First, the exclusive focus an the causal impacts of the Structural Fund policies (in isolation) an economic activity tends to neglect the fact that economic activity in any country or region is affected by a wide range of other policy shocks (e.g., fiscal, monetary, industrial, social, labour market etc) and other external shocks (developments in world growth, oil shocks, wars, etc). The beneficial impacts of the 1994-99 Structural Funds are likely to operate in conjunction with other policy shocks and it may be very difficult to disentangle the isolated impacts of the Structural Funds in a completely satisfactory way. The HERMIN models attempt to disentangle the separate Structural Funds impacts, using the methodology described in the MEANS handbooks (see ESRI, 1997).

Second, the manner of incorporating the Structural Fund mechanism into the HERMIN model draws an very recent economic research that itself has only just begun to address the questions of the relationship between increased

public investment and the consequences for improved levels of economic activity and development

Third, the HERMIN models themselves are not above criticism, and other models - that exhibit other disadvantages than HERMIN - could be used and would be likely to give different answers. For example the Commission's own QUEST model - which incorporates strong "crowding-out" mechanisms due to the inclusion of model-consistent expectations mechanisms - tends to give lower Structural Fund impacts. A recent survey of cohesion policy analysis by researchers at the Dutch CPB suggests that simpler single-equation econometric techniques should be used, and this approach also suggests much smaller policy impacts (Ederveen et al 2002a and 2002b). So, the methodology based an the HERMIN models is just one of many possible alternatives.

The following provides a summary of the overall impact of the CSF 94-99 in the four Member States: Greece, Ireland, Portugal and Spain and the macro regions East Germany and Northern Ireland. A more comprehensive analysis is set out in Bradley, Morgenroth and Untiedt (2003).

lt should be strongly re-emphasised that the numbers in all tables that follow show only the impacts of the public expenditure elements of the Structural Funds, i.e., the EU contribution plus the national public co-financing element. All national private co-fmancing has been excluded. This means, that the impact results could be taken as representing a lower bound, since not all elements of private co-finance are included as multiplier benefits of purely public sector actions.

To assist in the interpretation of the subsequent Structural Fund simulation results, it is useful to keep some summary measures in mind. The total size of the (public) Structural Funds in each country relative to its GDP (GECS-FRAT) is shown in Table 1. As a share of total GDP, the largest Structural Funds were those of Greece and Portugal, where the Structural Fund expenditures constituted about 3 percent of GDP per annum. The next largest was that of Ireland, between 1.4 and 1.8 percent of GDP. Spain was the smallest, at about 1.2 percent of GDP'[4].

Although the magnitudes of the Structural Fund impacts will differ from model to model, the characteristic pattern is similar for all models, and merits some explanation. The planned Structural Funds expenditures in each Gase tended to follow a similar pattern. This pattern involved a subdivision into the three main economic categories (physical infrastructure, e.g. roads, buildings etc., human resources, e.g. training and skills development, and aid to the productive sectors, e.g. investment support and subsidies). Within these cate-

1 4. In the Gase of Spain only certain regions were designated Objective 1. But our Spanish HERMIN model is for the entire economy, and we treat the Structural Funds "as if' Spain was an Objective 1 country.

Table 1 - Total Structural Funds expenditure as percentage of GDP (GECSFRAT)

	Greece	*Ireland*	*Portugal*	*Spain*
1993	*0.00*	*0.00*	*0.00*	*0.00*
1994	*3.19*	*1.68*	*3.17*	*1.16*
1995	*3.05*	*1.75*	*3.03*	*1.15*
1996	*2.99*	*1.67*	*3.00*	*1.17*
1997	*2.89*	*1.56*	*2.95*	*1.19*
1998	*2.90*	*1.50*	*2.96*	*1.22*
1999	*2.95*	*1.39*	*3.00*	*1.24*

gories, the published planned financial expenditure data in the Structural Fund programmes showed that an approximately equal amount of expenditure was envisaged for each of the six years (1994-1999). In terms of its demand-side (or Keynesian) impacts, this will result in a sharp increase in activity in the first year, and the increase will be sustained for the six years 1994-1999, inclusive. However, after the year 1999 the artificial assumption is made that the 1994-99 Structural Fund expenditures cease abruptly, or are quickly wound down, and the demand-side (or Keynesian) impacts return to zero. There is therefore a public expenditure contraction, and the only longer-term benefits are those that stem from the externalities (or indirect supply-side) impacts associated with the sustained increase in the stock of physical infrastructure and human capital.

In reality, the ex post (or actual) Structural Fund expenditure tended to follow a slightly different pattern. As the 1994-99 Structural Funds were implemented, the construction and training programmes were likely to be phased in more gradually, even if the actual financial expenditures were batched as in the Structural Fund financial tables. For example, in the case of the Greek Structural Funds, the planned expenditures were radically altered, and phased so as to be "back-loaded" towards the middle and end of the period of operation. In the absence of detailed information an the actual phasing of Structural Fund activities an an annual basis and for all programmes, we were obliged to use the published financial data that are available for Greece. Consequently, while the actual patterns of Structural Funds impacts are a little artificial, the smoothed average effect is probably fairly realistic. This suggests that, in the case of the Greek Structural Funds, the model results should not be used to explore dynamic impacts within the period 1994-99, but should be used to gauge medium and long-term impacts. In the cases of Ireland, Portugal and

Table 2 - Structural Funds 94-99 impacts an GDP (GDPE) and unemployment (UR)

	Greece		*Ireland*		*Portugal*		*Spain*	
	GDPE	*UR*	*GDPE*	*UR*	*GDPE*	*UR*	*GDPE*	*UR*
1993	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1994	2.01	-1.38	1.61	-0.96	2.72	-2.21	1.10	-0.98
1995	1.94	-1.19	2.02	-1.07	2.78	-1.76	1.18	-0.83
1996	1.95	-0.97	2.17	-0.92	2.87	-1.31	1.25	-0.57
1997	1.90	-0.68	2.34	-0.73	3.30	-0.73	1.32	-0.19
1998	2.03	-0.40	2.76	-0.51	4.04	-0.16	1.39	+0.30
1999	2.16	-0.31	2.83	-0.35	4.66	-0.05	1.39	+0.60
2000	0.44	+1.00	1.56	+0.53	2.20	+1.93	0.18	+1.78
2005	0.71	+0.68	1.20	+0.49	2.40	+1.09	0.63	+0.38
2010	0.66	+0.58	1.00	+0.40	2.06	+0.82	0.58	+0.35

Spain, the planned and actual 1994-99 Structural Fund expenditures did not differ greatly from each other.

In Table 2 the impact of the Structural Funds an the level of aggregate real GDP at market prices (as a percentage change relative to the no- Structural Funds baseline-1993), and an the unemployment rate (as a *difference* relative to the no- Structural Funds baseline-1993) are shown.

The Structural Funds raise the level of Greek GDP (measured at constant market prices) by about 2 percent over the "no-Structural Funds" baseline during the period 1994-1999. This impact falls to below 0.5 percent in 2000, but increases gradually to just under 0.7 percent by the year 2010. In the early years, the Structural Funds reduces the unemployment rate by about 1.4 percentage points (in the initial year), but this declines to a reduction of only 0.3 percentage points by 1999. After the demand-side stimulus is removed, the unemployment rate rises again, mainly because productivity is now higher than in the "no-Structural Funds" case. But of course in practice one would never observe this "pure" impact, since in the post- Structural Funds 94-99 era, many other external and policy variables would also be changing (e.g., the implementation of the 2000-2006 Structural Funds)".

15. Once again, it should be stressed that the Structural Funds shock being analysed consists of the 1994-99 Structural Funds in isolation. The impacts that the model simulates post-1999 would never be observed in practice because the 2000-2006 Structural Funds will take

Turning to Ireland, it is seen that the impact an the level of GDP in Ireland peaks at just under 3 percent in the year 1999, and in the Tonger term the impact is just over 1 percent. During the operation of the 1994-99 Structural Funds the effect is to reduce the rate of unemployment, and the pattern follows the Greek case: i.e., an initial one percentage point cut in the unemployment rate, followed by smaller impacts as the productivity impacts of the Structural Funds build up, and a reversal of these cuts after the termination of the Structural Funds beyond 1999.

Turning to Portugal, the aggregate impacts an the level of GDP are quite large, and peak at just over 4.5 percent in 1999. The impact an the rate of unemployment follow the Greek and Irish patterns, with an initial strong negative impact, followed by smaller negative impacts, and a reversal of the sign of the impacts after the Structural Funds is complete.

In the Gase of Spain, it must be stressed that this country was divided into Objective 1 regions and non-Objective 1 regions. In the above tables what we show are the impacts an the entire Spanish economy, and not just an the Objective 1 regions. In the case of the aggregate GDP impacts, these appear small, but should be scaled in terms of the smaller size of the Structural Funds relative to the national Spanish GDP.

In comparing the sizes of the impacts an the level of GDP, the size (or scale) of the Structural Funds injection (both EU and domestic public sector co-finance) must be borne in mind. A large Structural Fund impact in terms of an increase in the level of GDP may simply arise because the Structural Fund expenditures are large as a fraction of GDP. We need to normalise for this scale effect, and as a guide we can construct a type of "cumulative" Structural Fund multiplier defined as follows:

Cumulative Structural Fund multiplier:

Cumulative percentage increase in GDP / Cumulative SF share in GDP

Table 3 shows the cumulative multiplier (defined as above) for GDP for the years 1994-1999, 1994-2002 and 1994-2010 for the 1994-99 Structural Funds. For Greece the cumulative SF multiplier is seen to rise from the value 0.67 for 1994-1999, to 0.76 for 1994-2002, and rises further to 1.07 for 1994-2020. Thus, after all planned 1994-99 SF expenditures effectively cease after

over, or in the case of Ireland, the domestic funding of the Irish National Development Plan for 2000-2006 (of which the Structural Funds are a small part) is very much larger than the 1994-99 Structural Funds.

Table 3 - Synthetic Structural Funds cumulative "multiplier" an GDP

	Ireland	*Portugal*	*Spain*	*Greece*
1994-1999	*1.44*	*1.12*	1.07	0.67
1994-2002	*1.88*	*1.53*	*1.23*	0.76
1994-2010	*2.83*	*2.55*	1.77	1.07

the year 1999, there are continuing supply-side benefits in later periods due to the externality mechanisms described in the previous section. In the absence of such mechanisms, the cumulative SF multiplier would remain at a value of about 0.7. What is striking in this table is that the cumulative SF multipliers are quite large for Ireland compared to Greece". Clearly the Irish economy responds to the Structural Fund shock in a more growth-oriented way, and the greater degree of openness facilitates greater transitional growth. These structural features of the Irish economy have been captured by the HERMIN model.

In Portugal, the cumulative SF multipliers are seen to be at the higher end of the scale. However, although the increase in the level of GDP in Portugal is higher than in Ireland, due to the fact that the Structural Funds forms a higher percentage of GDP, the Portuguese cumulative multipliers are slightly lower than those for Ireland. This also reflects the openness of the Portuguese economy, which is in the range between that of Greece and Ireland. In Spain, the cumulative multipliers are bigger than the Greek case, but smaller than the Portuguese case. Surprisingly, the Spanish economy is more open than the Greek economy, even though one would have expected openness to decline as size increases. One is tempted to conclude that while the Structural Fund investment programmes were relatively more effective for Ireland, Portugal and Spain than for Greece, their reduced effectiveness in the case of Greece has deep roots in the sectoral structure and properties of the Greek economy that have proved difficult to change since 1989.

Two large macro-regions were included within the context of Objective 1 for the 1994-1999 Structural Funds: the East German Lander and the *Mezzogiorno* region of Italy. A HERMIN modelling exercise has been undertaken for Eastern Germany and the result of this are reported below, in the same format adopted above. Although Northern Ireland is only one of the twelve standard economic regions of the United Kingdom, we include it as a macro-region, mainly because it has reasonably comprehensive regional accounts, is sufficiently large (with a population greater than that of Estonia or Slovenia), and has a range of devolved policy-making powers.

[6. It should be recalled that the Same externality elasticities are used in all the Structural Funds.

Table 4 -Total Structural Funds expenditure as percentage of GDP (GECSFRAT)

	East Germany	*Northern /reland*
1993	0.00	0.00
1994	2.01	1.00
1995	1.78	1.12
1996	1.83	1.47
1997	1.92	1.19
1998	1.98	0.96
1999	1.94	0.90

The total size of the Structural Fund programme in each region relative to its GDP (GECSFRAT) is shown in Table 4. The average was about 2 per cent of GDP in the case of East Germany, but was considerably smaller in the case of Northern Ireland.

The East German economy started from a very low Base after German unification, and it is not surprising that the HERMIN model suggests that - other things being equal - the East German economy is likely to grow rapidly 17. Table 5 suggests that the impact of the 1994-99 Structural Funds an the level of aggregate GDP may be as high as 4 percent by the year 1999, and will continue into the post- Structural Funds period. Although there is a lowering of the impact an GDP after the Structural Funds terminate, due to the externality impacts, the Tonger term impact endures. This impact is somewhat surprising, but is partially explained by the close links between East and West Germany, and the fact that the types of isflation and labour market pressures that arise in national economies tend not to be so severe in the case of regional economies. The HERMIN model incorporates these features.

The impact an reducing the unemployment rate is also strong, although this is reversed in the period after the termination of the Structural Funds. Once again, it should be stressed that the Structural Funds shock being analysed consists of the 1994-99 programme in isolation. The impacts that the model simulates post-1999 would never be observed in practice because the new Structural Fund programme for 2000-2006 took over.

Northern Ireland is one of the least developed regions of the United Kingdom, but since the UK is at the average GDP per capita within the EU, it

17. The new growth theory suggests that the crucial driving force for convergence of a lagging economy is the initial state of the economy (Barro and Sala-i-Martin, 1995).

Takle 5-Structural Funds 94-99 impacts an GDP (GDPE) and unemployment (UR)

	East Germany		*Northern Ireland*	
	GDPE	*UR*	*GDPE*	*UR*
1993	0.00	0.00	0.00	0.00
1994	2.75	-1.89	1.09	-0.41
1995	2.85	-1.85	1.27	-0.51
1996	2.92	-1.76	1.77	-0.71
1997	3.24	-1.73	1.59	-0.57
1998	3.71	-1.49	1.34	-0.43
1999	3.95	-1.32	1.27	-0.39
2005	2.76	+1.26	0.18	+0.04
2010	4.68	+1.74	0.12	+0.04

* For **Northern Ireland the CSF 1994-1999 expenditures terminated after the year 2001.**

is clear that Northern Ireland is relatively better off than the countries of the Southern EU periphery. Nevertheless, it was designated Objective 1 for the purposes of the 1994-99 Structural Funds and was the largest UK region to be so designated. Since we had full ex-post Structural Funds financial data an Northern Ireland from an early stage, we use these data rather than the ex-ante planning data used in all the previous simulations. The Structural Funds expenditures continued beyond 1999 and were sizeable in the years 2000 and 2001.

The results for Northern Ireland are presented in the saure format as for East Germany. Table 5, shows the simulation results in relation to the impact of the 1994-99 Structural Funds an the level of aggregate real GDP at market prices (as a percentage change relative to the no-Structural Funds baseline), and an the unemployment rate (as a *differente* relative to the no- Structural Funds baseline). In this case we had access to annual ex-post Structural Funds expenditures, which continued beyond the year 1999 to a modest extent.

The Northern Ireland economy started from a moderately high base in 1993, but was only beginning to emerge from a period of over a quarter of a century of civil unrest and violence that had a severe negative impact an private sector activity's. Table 5 suggests that the impact of the 1994-99 Structural Funds an the level of aggregate GDP rose to just above 1.75 per-

18. The ferst "cease fires" of the main paramilitary organisations were announced in 1994, subsequently broke down, and were reinstated. **The Belfast Agreement that eventually led to devolved government only came at the end of the** period of Structural Funds/SPD 94-99. So the political context of Structural Funds/SPD 94-99 in Northern Ireland continued to be one of uncertainty and evolution.

Table 6 - Structural Funds cumulative "multiplier" an GDP

	East Germany	*Northern lreland*
1994-1999	*1.69*	*1.24*
1994-2002	*2.11*	*1.33*
1994-2010	*4.44*	*1.48*

cent by the year 1996, but that the positive impact an the level of GDP declined almost to zero after 2001. The impact an reducing the unemployment rate was modest, peaking at a reduction of just over 0.7 percentage points in the year 1996, but declining to almost zero after 2001.

The cumulative SF multiplier (defined previously) is shown in Table 6 for the years 1994-1999, 1994-2002 and 1994-2010. In the case of East Germany, these are among the highest cumulative multipliers of the six economies that we have modelled using HERMIN. This appears to fly in the face of the stalled convergence of the East German economy that is apparent when aggregate data an macro-economic performance is examined for the period 1994-1999. The problem here is probably more associated with the poor performance of the economy of the former West Germany than with any failure in the East German Structural Funds. Although the HERMIN analysis suggests that the Structural Fund impacts an the East German regions were large and positive, the negative effects from the external economy (mainly West Germany) have probably dominated the positive Structural Fund impacts and so the aggregate performance as observed in the historical data is quite weak. This serves to emphasise the fact that the Structural Funds mechanisms are merely one factor in the decomposition of aggregate development performance.

The cumulative multipliers for Northern Ireland are among the lowest cumulative multipliers of the six cases that have been evaluated using HERMIN models. More detailed work which is not shown here for space reasons suggest that much of the SF funding was spent an construction and training activities, and that the manufacturing sector - where the enduring long-lasting impacts of the SPD tend to arise - was less affected. Thus, the Jong-run benefits were truncated and the cumulative multipliers were correspondingly smaller.

5. Summary and Conclusions

This paper has outlined the HERMIN modelling framework, which has been widely used for Structural Fund analysis. The use of such a fully speci-

fied multi-equation econometric model has the advantage of capturing even the indirect impacts of the Structural Funds. The model has Keynesian small open economy theoretical foundations but also incorporates neo-classical supply side effects and crucially for the Structural Fund analysis it incorporates mechanisms which are based an the endogenous growth literature that capture the long-run impact of Structural Funds investments. A further strength of this modelling framework is that while it utilises a common structure for all regions and countries the individual models are tailored to the specific region/country. Thus each model reflects the peculiar economic structure of the particular region/country.

A number of avenues for further research arise out of the work that was carried out for the ex-post evaluation of the Structural Funds that was outlined above. Clearly, the model is a relatively simple characterisation of each of the economies. Further, extensions would make the model more realistic. For example, the model could be extended to additional sectors, particularly those that are of a high importance for the particular economy. This would allow us to evaluate the impact of the Structural Funds an sectors that are strategically important. A further extension that would yield additional insights is the linking of regional economies through spillovers, in addition to migration and commuting, as well as features of the new economic geography literature such as agglomeration economies. In addition to this the linkages between regions can also be modelled more comprehensively. However, all these possible developments will clearly depend an the availability of data.

The evaluation of the 1994-1999 Objective 1 Structural Fund programmes was presented, and yielded some interesting results. In general the Structural Funds appear to have had a positive impact both an GDP and an unemployment rates. However, some large differences between economies are apparent. Thus, the largest impact as measured by the cumulative multiplier appears to have been in East Germany, which might be somewhat surprising. However, this effect appears to have been dominated by other negative effects yielding the modest overall economic performance of East Germany. The lowest impact was found for Greece, and this might be linked to the relatively low level of economic openness of that country.

Finally, the direct benefits arising from the Structural Funds are only part of a much wider picture. The real long-term benefits of the Structural Funds are known to be associated with the way in which each economy (region) responds to opportunities arising in the rest of the country and the EU as a result of the Single Market rather than from the Structural Funds in isolation. This emphasises the need to work within the wider "global theory" of macro modelling rather than the narrower "theory of action" that tends to motivate policy makers who are focused an the role of specific Structural Funds programmes.

Of course the HERMIN framework is not without weaknesses. For example the evaluations are dependent an the chosen externality elasticities. Increasing the size of the externality elasticities boosts the impact of the Structural Fund programmes. Since precise values of the elasticities are not known, a range of possible Structural Fund impacts must be considered. However, sensitivity analysis suggests that the results are relatively robust.

Another possible weakness is the relatively high level of sectoral aggregation. For policy makers, particularly those interested in industrial policy a breakdown of for example manufacturing into sub-sectors would be interesting as certain sectors may benefit more or less from the Structural Funds. Against that one has to consider the issue of data availability and analytical complexity that further disaggregation would introduce. Nevertheless, efforts are underway to disaggregate the sectors further.

The various models are currently not explicitly linked to each other. The exceptions here are migration and commuting flows, which in the case of the regional models are incorporated and the exogenous demand linkages that are also a feature of the model. However, particularly at the regional level a more explicit linkage between the models this is highly desirable, as this would allow spatial effects to be incorporated in the HERMIN model. This remains a task for the future.

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