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

John Bradley*, Edgar Morgenroth* and Gerhard Untiedt**

*** Economic & Social Research Institute (ESRI), Dublin**
**** Gesellschaft für Finanz- und Regionalanalysen (GEFRA), Münster**

Abstract: The structural fund interventions play a crucial role in improving the social and economic cohesion of the EU. A particular focus of the structural funds is on Objective 1 regions that lag behind to the extent that their GDP per capita is below 75 per cent of the EU average. The amount of investment that is funded though the Structural Funds by the EU is substantial and consequently EU legislation requires the appraisal of the structural funds. However, while systematic monitoring and evaluation frameworks are available at the national level and at the project level, a rigorous and systematic method for quantifying the socio-economic impacts of structural fund interventions on the regional economies has not been developed to the same extent. One modelling framework – HERMIN - has been widely applied to Structural Fund analysis at the national level and macro-regional level. The HERMIN framework is based on a small open economy model. Importantly it incorporates mechanisms, which are based on 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.

September 2003

1. Introduction

The 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 on those regions that lag behind to the extent that their GDP per capita is below 75 per cent of the EU average. These regions are classified as Objective 1 and make up a significant part of the EU. In 1999 these regions 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 unemployment.

The amount of investment that is funded though the structural funds 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. 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 on 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 structural fund interventions on the 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 on the macroeconomic and macro-sectoral performance at a regional (NUTS II) level, which would allow them to assess the overall impact of the structural funds.

Furthermore the estimation of the long-run impact of the Structural Funds is more important than the estimation of their simple Keynesian demand side impact, since the Structural Funds aim at changing the economic potential of a region over the long run rather than to provide a short run cash injection. This limits the number of potential methodologies since some are not 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 'of the peg' models are inadequate and instead for each country/ region the model coefficients and possibly the structure of the model need to be adjusted.

While this paper is not aimed at reviewing this literature on 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, I-O models, CGE models, single equation econometric models and multi-equation econometric models (see Ederveen et al., 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). However, 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.

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 on a 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) is still at a highly experimental stage and may be difficult to operationalise in the context of integrating its insights with the body of existing European work on the 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 funds 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 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.

Evaluation based on fully specified macroeconomic models is discussed, e.g., in Bradley et al. (1995), Roeger (1996) and ESRI (2002). The main advantage of such model-based evaluations is that they allow estimating 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. Thus, for example in the QUEST model (Roeger, 1996) crowding out reduces the overall estimated impact of the Structural Funds.

One modelling framework – HERMIN - has been widely applied to Structural Fund analysis at the national level (Greece, Ireland, Portugal, Spain, Czech Republic, Estonia, Latvia, Poland) and macro-regional level (East Germany and Northern Ireland).[1] 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 highlight the results 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 3 discusses the evaluation results of the HERMIN framework for the Structural Funds programmes for the period 1994-1999. Finally chapter 4 summarises the paper.

[1] 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).

2. The Structure and Theoretical Foundations of HERMIN

The basic macro-sectoral methodology appears to be the most 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 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 Funds 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 Funds 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 (mainly in the case of Ireland) and inward foreign direct investment.

(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 on key structural features of an Objective 1 economy with respect to such issues as:

(a) Economic openness, exposure to 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;

(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 that incorporates the theoretical underpinning of a small open economy model with a Keynesian role for domestic demand[2]. 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 Funds programme. The model is made up of three 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. Thus, the interaction of the expenditure and income distribution sub-components generate the standard multiplier properties of the HERMIN model.[3] However, the model also

[2] 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.
[3] 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 CSF expenditures are mainly on public goods (e.g., physical infrastructure and education/training), it might be questioned if "crowding out" is fully relevant. In

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

---

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).

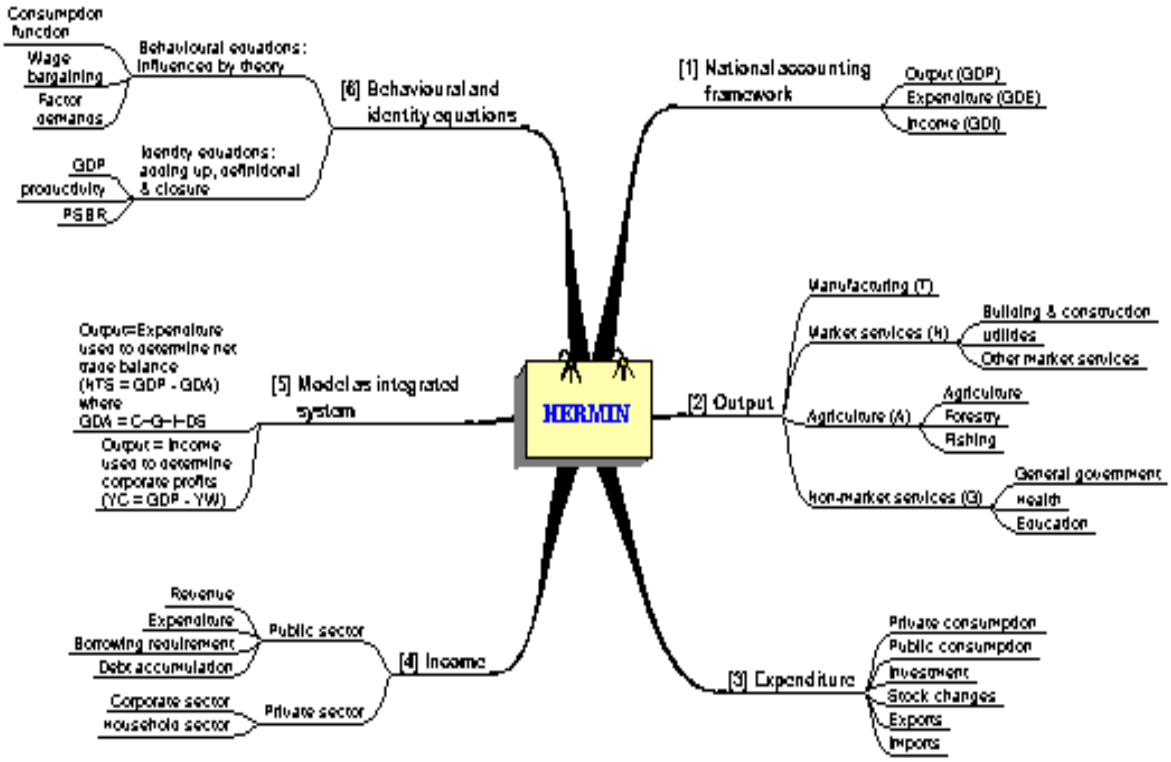

Figure 1: Schematic outline of the HERMIN modelling approach

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 funds analysis since such investments are likely to generate large-scale inter-regional demand and supply spillovers.

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 the existing macro-region models.

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 WINSOLVE software package.

3. Incorporating the Impact of the Structural Funds

At the national and regional level the Structural Funds 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. There are various reasons for this. First, although it is necessary to present a Structural Funds 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 impact of a new road in one sub-region as compared with another sub-region.[4] Third, if the Structural Funds 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. The most 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;

[4] Of course, in the design of a Structural Funds, a sub-regional breakdown is an essential part of comparing the benefits of alternative investment strategies. But our brief in this project is to analyse the macro impacts of the actual Structural Funds 94-99, and not to speculate on the likely impacts of alternative Structural Funds.

b. Domestic public sector co-financing as set out in the Structural Funds treaties;[5]
c. Domestic private sector co-financing as set out in the Structural Funds treaties.

Inclusion of the private sector co-financing is at best problematic, and they are ignored in our analysis. Of course, there are indirect impacts of publicly financed Structural Funds investment on 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 Funds expenditures, and since no methodology exists to model them, they are best excluded.[6]

Structural Funds actions influence the Objective 1 economies through a mixture of supply and demand effects. Short-term demand (or Keynesian) effects arise in the models as a consequence of increases in the expenditure and income policy instruments associated with Structural Funds 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 *raison d'etre* of the Structural Funds, but merely a side-effect. Rather, the Structural Funds 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.

[5] Note that "domestic" public sector co-finance 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.
[6] In the simulations carried out for the European Commission, we were asked to exclude all private sector co-finance, so as to identify the impact of the EU and public expenditure only.

Thus, the Structural Funds 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, productivity 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 Funds 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 long-run impact of the Structural Funds and thus, to properly assess the impact of the Funds these must 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 restricted context of fixed output, labour is 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 is fixed. However, on the plus side, factor productivity is driven up, real incomes rise, and these effects cause knock-on multiplier and other benefits throughout the economy. 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, particularly in relation to infrastructure, have been chosen on the basis of an exhaustive literature review (see Bradley, Morgenroth and Untiedt, 2001 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. However, since such elasticities do not exist for many regions and some 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 Funds 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 of over the programming period

1994-1999. 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 Structural Funds 94-99 was implemented), and continue the simulation out to the year 2010, i.e., eleven years after the termination of Structural Funds, 94-99. For the purposes of isolating the separate impacts of Structural Funds 94-99, we ignore the carry-over impacts of Structural Funds 89-93, as well as the continuation of Structural Funds aid under the current Structural Funds 2000-2006. We then "extract" the Structural Funds 94-99 policy shocks, i.e., we set the Structural Funds 94-99 expenditures at zero and re-simulate the model[7]. No other changes are made, and no attempt is made to design a "substitute" domestically funded public investment programme that would have replaced a "missing" Structural Funds 94-99. This is a very artificial assumption, since in the absence of Structural Funds 94-99 there almost certainly would have been substitute domestically funded public investment programme, albeit smaller in magnitude[8].

Ideally we should use the actual ex-post realised Structural Funds expenditures. But these were not available for every country or region.[9] In the interests of uniformity, in this section we have used the planned Structural Funds expenditure data as contained in the Structural Funds 94-99 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 later years.

[7] 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 Funds-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.

[8] This involves the usual assumption of quasi-linearity which is valid for most standard macro models.

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

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. 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 Structural Funds 94-99 was implemented), and continue the simulation out to the year 2010, i.e., eleven years after the termination of Structural Funds 94-99. 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 Structural Funds 94-99, we ignore the carry-over impacts of Structural Funds 89-93, as well as the continuation of Structural Funds aid under the current Structural Funds 2000-2006. Any examination of the actual outturn for the period 1994-2001 will show the results of a "with- Structural Funds" policy framework. Thus, this outturn included the carry-over from Structural Funds 89-93, the implementation of Structural Funds 94-99, and the initial year of Structural Funds 2000-2006 (when available). Consequently, a simple examination of the actual macroeconomic outturn will present a misleading impression of the likely role played by Structural Funds 94-99 in isolation from other Structural Funds.

iii. The inclusion of the Structural Funds investment expenditures triggers a build up of the stock of physical infrastructure and human capital. As explained in Section 2 (Methodology), 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 Structural Funds 94-99 public policy shocks (i.e., EU and domestic public expenditures) from the above simulation, i.e., we set the Structural Funds 94-99 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 a "missing" Structural Funds 94-99. This is a very artificial assumption, since in the absence of Structural Funds 94-99 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 CSF 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 CSF 94-99 on GDP?", is likely to be disappointed. Indeed, such a question is conceptually vague and ill-posed for a number of reasons.

- The exclusive focus on the causal impacts of the Structural Funds policies (in isolation) on 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 Structural Funds 94-99 are likely to operate in conjunction with other policy shocks and it may be difficult, or impossible, 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.

- The manner of incorporating the Structural Funds mechanism into the HERMIN model draws on 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

- The HERMIN models themselves are not above criticism, and other models 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 Funds 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 2002 a and 2002b). So, the methodology based on 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 the ESRI report (ESRI, 2002).

It 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/SPD, i.e., the EU contribution plus the national public co-financing element. All national private co-financing 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. Indeed, there were cases described in earlier sections where the private co-finance elements came in far below their targeted levels.

To assist in the interpretation of the subsequent Structural Funds 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 (GECSFRAT) is shown in Table

1. In Table 1, the historical GDP outturn is used to calculate the percentage share, GECSFRAT, i.e., the Structural Funds public expenditures expressed as a percentage of GDP. As a share of total GDP, the largest Structural Funds were those of Greece and Portugal, where the Structural Funds 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.[10]

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

	Greece	Ireland	Portugal	Spain
1993	0	0	0	0
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

Although the magnitudes of the Structural Funds 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 case 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 categories, the published planned financial expenditure data in the Structural Funds/SPD treaties 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 Structural Funds 1994-99 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.

[10] In the case 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

In reality, the ex post (or actual) Structural Funds/SPD expenditure tended to follow a slightly different pattern. As the new Structural Funds 1994-99 was 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 Funds financial tables. 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 of Structural Funds 94-99. In the absence of detailed information on the actual phasing of Structural Funds activities on 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 Spain, the planned and actual Structural Funds 94-99 expenditures did not differ greatly from each other.

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

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

country.

	Greece		Ireland		Portugal		Spain	
	GDPE	UR	GDPE	UR	GDPE	UR	GDPE	UR
1993	0	0	0	0	0	0	0	0
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

The Structural Funds raises 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 Structural Funds 2000-06). [11]

Turning to Ireland, it is seen that the impact on the level of GDP in Ireland peaks at just under 3 percent in the year 1999, and in the longer term the impact is just over 1 percent. During the operation of Structural Funds 94-99 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 on the level of GDP are quite large, and peak at just over 4.5 percent in 1999. The impact on the rate of unemployment follow the Greek and Irish patterns, with an initial strong negative impact, followed by

[11] Once again, it should be stressed that the Structural Funds shock being analysed consists of Structural Funds 94-99 in isolation. The impacts that the model simulates post-1999 would never be observed in practice because Structural Funds 2000-06 will take over, or in the case of Ireland, the

smaller negative impacts, and a reversal of the sign of the impacts after the Structural Funds is complete.

In the case of Spain, it must be stressed that this country was divided into Objective 1 regions and non-Objective 1 regions. In the following tables what we show are the impacts on the entire Spanish economy, and not just on 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 on 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 Funds impact in terms of an increase in the level of GDP may simply arise because the Structural Funds 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 Funds multiplier defined as follows:

***Cumulative* Structural Funds *multiplier*:**

Cumulative percentage increase in GDP / Cumulative* Structural Funds *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 Structural Funds 94-99. For Greece the cumulative Structural Funds 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 CSF 94-99 expenditures effectively cease after the year 1999, there are continuing supply-side benefits from the Structural Funds in later periods due to the externality mechanisms described in the previous section. In the absence of such mechanisms, the cumulative Structural Funds multiplier would remain at a value of about 0.7. What is striking in this table is that the cumulative Structural Funds 94-99

domestic funding of the Irish NDP 2000-06 (of which Structural Funds 2000-06 is a small part) is very much larger than Structural Funds 94-99.

multipliers are quite large for Ireland compared to Greece.[12] Clearly the Irish economy responds to the Structural Funds 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 Structural Funds 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 Funds 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.

Table 3: Synthetic Structural Funds cumulative "multiplier" on 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

nt.

Two large macro-regions can be identified within the context of Objective 1 1994-1999: the east German Lander and the Mezzogiorno 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.

[12] It should be recalled that the same externality elasticises are used in all the Structural Funds.

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

Table 4 Total Structural Funds expenditure as percentage of GDP (GECSFRAT) East Germany and Northern Ireland

	East Germany	Northern Ireland[13]
1993	0	0
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 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.[14] Table 5 suggests that the impact of Structural Funds 94-99 on the level of aggregate GDP may be as high as 4 percent by the year 1999, and will continue into the post- Structural Funds 94-99 period. Although there is a lowering of the impact on GDP after Structural Funds 94-99 terminates, due to the externality impacts, the longer 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 inflation 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 on reducing the unemployment rate is also strong, although this is reversed in the period after the termination of Structural Funds 94-99. Once again, it should be stressed that the Structural Funds shock being analysed consists of Structural Funds 94-99 in isolation. The impacts that the model simulates post-1999 would never be observed in practice because Structural Funds 2000-06 will take over.

[13] The values of GECSFRAT for Northern Ireland in 2000 and 2001 are 0.65 and 0.34 respectively.
[14] 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).

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 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 Structural Funds 94-99 and was the largest UK region to be so designated. Since we had full ex-post Structural Funds financial data on 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/SPD expenditures continued beyond 1999 and were sizeable in the years 2000 and 2001.

The results for Northern Ireland are presented in the same format as for East Germany. Table 5, shows the simulation results in relation to the impact of the Structural Funds/SPD 1994-99 on the level of aggregate real GDP at market prices (as a percentage change relative to the no- Structural Funds baseline), and on the unemployment rate (as a difference relative to the no- Structural Funds baseline). In this case we had access to annual ex-post Structural Funds /SPD 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 on private sector activity.[15] Table 5 suggests that the impact of SPD 94-99 on the level of aggregate GDP rose to just above 1.75 percent by the year 1996, but that the positive impact on the level of GDP declined almost to zero after 2001. The impact on 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.

[15] The first "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 5 Structural Funds 94-99 impacts on GDP (GDPE) and unemployment (UR)

	East Germany		Northern Ireland	
	GDPE	UR	GDPE	UR
1993	0	0	0	0
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.

The cumulative multiplier (defined previously) is shown in Table 6 for the years 1994-1999, 1994-2002 and 1994-2010 for Structural Funds 94-99. 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 East Germany that is apparent when aggregate data on 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 Funds impacts on the East German regions were large and positive, the negative effects from the external economy (mainly West Germany) have probably dominated the positive Structural Funds 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 SPD funding was spent on 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 long-run benefits were truncated and the cumulative multipliers were correspondingly smaller.

Table 6: Structural Funds cumulative "multiplier" on GDP

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

5. Summary and Conclusions

This paper has outlined the HERMIN modelling framework, which has been widely used for Structural Funds analysis. The use of such a fully specified multi-equation econometric model has the advantage of capturing even the indirect impacts of the Structural Funds. The outline showed that the model Keynesian small open economy theoretical foundations but also incorporates neo-classical supply side effects and crucially for the Structural Funds analysis it incorporates mechanisms which are based on 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.

The evaluation of the 1994-1999 Objective 1 Structural Funds programmes yielded some interesting results. In general the Structural Funds appear to have had a positive impact both on GDP and on 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 shown 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 on the role of specific Structural Funds programmes.

Of course the HERMIN framework is not without weaknesses. For example the evaluations are dependent on the chosen externality elasticities. Increasing the size of the externality elasticities boosts the impact of the Structural Funds programmes. Since precise values of the elasticities are not known, a range of possible Structural Funds 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 form 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 HERMNIN model. This remains a task for the future.

6. References

Barro, R. and Sala-i-Martin, X. (1995). *Economic Growth*, New York, McGraw Hill.

Beutel, J. (2002) *The Econmic Impact of Objective 1 Interventions for the period 2000 - 2006*. Final Report to DG-REGIO May.

Bradley, J. (1998). "Policy Design and Evaluation: EU Structural Funds and Cohesion in the European Periphery", *Proceedings of the 10th Anniversary Congress of the Tinbergen Institute*, F. den Butter and M. Morgan (eds.), Amsterdam.

Bradley, J., Fitzgerald, J. (1988), "Industrial output and factor input determination in an econometric model of a small open economy". *European Economic Review* 32, 1227-1241.

Bradley, J., Morgenroth, E. and G. Untiedt (2000) *Analysis of the Macroeconomic Impact of the CSF on the Economy of East Germany*, Ifo Dresden Studien No. 30. Dresden: Ifo Institut fur Wirtschaftsforschung.

Bradley, J., K. Whelan and J. Wright (1995) "HERMIN Ireland". *Economic Modelling*, 12(3), pp. 249-274.

Bradley, J., and K. Whelan, (1997) "The Irish Expansionary Fiscal Contraction: A Tale from One Small European Economy", *Economic Modelling*. 14(2), pp. 175-201

De la Fuente, A. (1996). *Inversion Publica Y Redistribucion Regional: El Caso De Espana En La Decada de Los Ochenta. Barcelona* (Papers de Treball 50.96)

De la Fuente, A. and Vives, X. (1995). *Infrastructure and Education as Instruments of Economic Policy: Evidence from Spain*. Economic Policy, 20.

Ederveen, S., H. De Groot and R. Nahuis (2002) "Fertile Soil For Structural Funds?", *Tinbergen Institute Discussion Papers*, 02-096/3.

Ederveen, S., J. Gorter, R. de Mooij and R. Nahuis (2002) *Funds and Games: The Economics of European Cohesion Policy*. CPB Netherlands Bureau for Economic Policy Analysis, The Hague.

ESRI (1997). *Single Market Review 1996: Aggregate and regional impact: the cases of Greece, Spain, Ireland and Portugal*, Office for Official Publications of the European Communities in association with Kogan Page, London. (168 pages).

ESRI (2002) *An examination of the ex-post macroeconomic impacts of CSF 1994-99 on Objective 1 countries and regions*. Dublin.

Fan, W. Treyz, F. and G. Treyz (2000) "An Evolutionary New Economic Geography Model", *Journal of Regional Science* Vol. 40(4), pp. 671-95.

Roeger, W. (1996) *Macroeconomic evaluation of the effects of Community Structural Funds with QUEST II*. Mimeo, European Commission, GDII.

Tondl, G. (1999) *What determined the uneven growth of Europe's Southern regions? An empirical study with panel data*. EUI working papers.

Treyz, G. (1993) *Regional Economic Modelling: A systematic Approach to Economic Forecasting and Policy Analysis*. Boston: Kluwer.