The potential and limitations of macroeconomic modelling for the evaluation of EU Structural Funds illustrated by the HERMIN model for East Germany

1 Introduction

The evaluation of public expenditure has three main objectives. Firstly, it should assess the relative efficiency of expenditure-based policies to achieve certain objectives compared to alternative policies such as, for example, lower taxes or structural reforms. Secondly, it should provide guidance to decision-makers on the most efficient ways of spending public money with regard to the objectives being pursued. Thirdly, it should provide accountability to taxpayers and show that their money is being used in the best way. The first kind of evaluation of alternative policies can rarely be found. While for a single project the second objective can be expected to predominate in an ex ante evaluation and the third in an ex post evaluation, this is less clear for policies where there is a multitude of projects and programmes. In this case, an ex post evaluation may also give guidance for new programmes and an ex ante evaluation can reassure taxpayers that the right decisions on spending are being taken.

There are a number of possible ways for evaluating the impact of public expenditure – such as the Structural Funds of the European Union – on the economic performance of the supported regions or nations. The essential differences between the methods used lie in the extent to which the rest of the economy is viewed as unchanged while a specific policy intervention is evaluated. The different points of view can be denoted as micro, meso and macro levels of evaluations.

At the micro level, i.e. in the case of an individual project, a conventional cost-benefit analysis can be carried out and the alternative projects can be ranked in decreasing order of their economic rate of return. However, this procedure often involves methodological problems to take into account the spillover effects and the externalities for the rest of the economy, so that it is only an incomplete measure of the impact on the economy. If we move up to the meso level and look at the total number of projects that were designed to deal with a specific problem (e.g. reducing long-term unemployment) we could judge this initiative as successful when the problem has diminished (i.e. the rate of long-term unemployment has been reduced). However, just looking at the specific problem does not tell the whole story since it ignores the possible impact of measures on the rest of the economy and vice versa, for example changes to the wage bargaining process or reductions in the social security payments of the employed. Looking at the micro or meso level may be appropriate as long as the extent of public expenditure is small compared to the level of economic activity of the supported area. If the scale of public expenditure is significant, which is the case for several Structural Funds programmes, the impact and effectiveness should be evaluated as an integrated whole, taking into consideration the economy-wide feedbacks and interactions. Furthermore, the evaluation should investigate the structural changes in the production possibilities of the supported economy, that improve the supply side and increase competitiveness.

In this paper we describe and explore the potential and limitations of macroeconomic models for evaluating the Structural Funds. In section 2 we review the macroeconomic evaluation experience that has been undertaken in the so-called cohesion countries Greece, Ireland, Portugal and Spain. Section 3 contains a brief description of a macroeconomic model of East Germany that has been developed in line with the HERMIN models of the cohesion countries. The model is noteworthy since it describes the behaviour of a region instead of a state and the model set-up had to recognise that East Germany is a transition economy like other eastern European economies. The channels whereby the Structural Funds change the supply-side of the East German economy are explained and some simulation results are presented. Section 4 concludes.

Evaluations of public expenditure should (1) assess the relative efficiency, (2) provide guidance to decision-makers and (3) provide accountability to taxpayers.

(*) Views expressed in the paper are exclusively those of the author and do not necessarily correspond to those of the European Commission, for whose Directorate-General for Economic and Financial Affairs (DG ECFIN) the author is working.

(1) Cf. Bradley 2000 a

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2. Macroeconomic modelling for the evaluation of EU Structural Funds

In several EU Member States, Structural Funds have reached a size of macroeconomic significance in relative terms, i.e. of up to 3% relative to gross domestic product (GDP). This is in particular the case where regions are eligible for support under “Objective 1” which aim to promote the development and structural adjustment of regions whose development is lagging behind, as measured by per capita GDP in purchasing power parities of less than 75% of the EU average. A pertinent issue of evaluation in these regions is thus whether Structural Funds are or have been able to contribute to their income convergence with the rest of the EU.

One approach to answering this question could be to look at the performance of GDP per capita relative to the EU average at the beginning and the end of the period of Structural Funds spending. Convergence towards the EU average would then indicate a successful use of Structural Funds, while divergence would indicate the opposite. However, in practice many factors may contribute to the income situation of a region so that even a positive impact of Structural Funds can be offset by other negative influences resulting in an overall negative income performance. Hence, the actual impact of Structural Funds is not measured by this approach. A further possible evaluation methodology is to simply add up the economic effects of all individual Structural Funds projects. However, this procedure neglects many aspects that are not relevant at a project level, but are of considerable importance at a macroeconomic level, such as:

- substitution and displacement effects from replacing activities outside a project;
- multiplier effects from the cumulative process of income being spent for consumption which again generates income etc.; or
- crowding-out effects on private investment arising from public expenditure through interest or exchange rate channels.

These two basic problems of the evaluation of aggregate effects, i.e. the identification of the counterfactual situation and the interplay of variables at a macroeconomic level, can be addressed by macroeconomic modelling. In giving a – necessarily – simplified picture of how an economy works they can simulate the mechanics of Structural Funds expenditure in comparing the two situations with and without the exogenous shock of Structural Funds, expressed as the deviation from the baseline scenario.

When different models are applied in evaluating the same Structural Funds programme and deliver different results, it is frequently asked which result should be considered to be the correct one. Apart from calculation errors in model structure or parameters, a model and its results as such are neither right nor wrong. Macroeconomic models mainly illustrate different channels of impact that are more adequate or less adequate with regard to the objectives of a policy intervention. For evaluating the impact of Structural Funds assistance under Objective 1, a macroeconomic model should thus focus on the long-term effects arising from improvements in infrastructure, human resources and private firms. These so-called supply-side effects can be expected to continue even when Structural Funds payments are assumed to stop. These effects are in addition to the standard Keynesian demand-side effects that level off shortly after payments come to an end and, although certainly important in economic terms, are less of a modelling priority for a policy intervention targeting sustained regional development.

A huge variety of macroeconomic models has been used for the evaluation of Structural Funds. Many economists and Member States’ authorities have developed their own macro models which are however difficult to compare. For the European Commission, basically three models have been used so far, each of which delivers results that are roughly comparable across Member States: an input-output model, the Commission’s QUEST II model and the HERMIN models.

Input-output (I/O) analysis allows for a more detailed view of the sectoral demand-side effects of Structural Funds expenditure. It is based on an I/O table which defines the technical relationships between the various sectors of production up to the final demand for goods and services. An inversion of this table allows a simulation of the impact of changes in final demand on the production activities. Beutel (1996) developed I/O models which estimated the impact of Structural Funds (excluding na-
tional co-financing) on the growth rates for Spain (0.3 for 1989-93 and 0.5 for 1994-99), Ireland (0.8 and 0.6), Portugal and Greece (both 0.9 and 1.0). A further interesting result is that on average about 20% of the Structural Funds given to these four countries leaks into other EU countries. However, the use of these models was not further pursued by the Commission given their focus on the demand side and the considerable efforts and time required to establish an I/O table which then only gives a historic picture of an economy rather than an analysis of the structural changes induced by the Structural Funds.

The QUEST II model has been used for the ex post evaluation of the programming period 1989-93, for the ex ante and mid-term evaluation of the programming period 1994-99 and for the ex ante evaluation of the programming period 2000-06. QUEST II is the Commission’s multi-country business cycle and growth model designed to analyse the economies of the EU Member States and their interactions with the rest of the world. The QUEST II model is forward-looking in basing its behavioural equations on the intertemporal optimisation of the decisions of households and firms. About 40 per cent of households’ consumption depends on current disposable income and about 60 per cent on the present value of expected future income, implying that households foresee future tax payments arising from higher public expenditure. In contrast to most other macroeconomic models, real interest and exchange rates are determined endogenously, so that possible effects of crowding-out of private investment are taken into account and tend to reduce the demand-side effects of public expenditure. The determinants of potential output, i.e. the supply side of the economy, are modelled explicitly with a neo-classical production function. The macroeconomic impact of the Structural Funds programme is modelled in terms of an increase in the public capital stock which is assumed to have positive externalities on the conditions of production.

The results of the QUEST II simulations for the period 2000-2006 for Greece, Spain, Ireland and Portugal are presented as a deviation from the baseline scenario i.e. the change in performance compared to a situation without CSF (Community Support Framework, consisting of EU Structural Funds and national public co-financing expenditure). As a purely technical assumption, payments are simulated to stop after 2006 so that only the supply-side effects continue (see Figure 1). Results for real GDP are relatively low compared to those of other models, essentially because of the assumption of forward-looking expectations and the endogenous determination of real interest and exchange rates. In the longer run (after about five years), the increase in GDP turns out to be higher than the induced short-term demand-side effects due to positive supply-side effects, which are of a more permanent nature and continue beyond the period of CSF payments. The GDP effects are similar for Greece and Portugal, on the one hand, and for Spain and Ireland, on the other hand, mainly because of the differing importance of Structural Funds payments relative to GDP. The long-term employment effects are modest due to the downward effect of productivity improvements on prices which drive up real wages. The relatively strong openness of the cohesion countries is reflected in the deterioration of the trade balance in the initial years and in the reduction of private investment, which is crowded out instead of being complementary to public investment. The mechanism generating these effects is the appreciation of the real exchange rate – due to the effects on the price level – which squeezes profits and reduces private investment.

The HERMIN models, whose features will be described more in detail in section 3 below, are four-sector macroeconomic models. They have been developed for the specific purpose of simulating EU cohesion input-output models, QUEST II and HERMIN are models which have delivered results that are roughly comparable across Member States.

Figure 1
QUEST II simulation results on the impact of the Community Support Frameworks 2000-2006 (% deviation of real GDP from baseline)

Source: European Commission 2000, p. 216

(3) See also European Commission 1996, p. 98
(4) See Roeger 1996, European Commission 2000, as well as the Objective 1 Community Support Frameworks for 2000-2006 for Greece, Spain, Ireland and Portugal
(5) See Roeger and In’t Veld 1997
countries’ economies, which are Greece, Spain, Ireland and Portugal, and the way that Structural Funds have an impact on these economies. They built on experience from the Commission’s HERMES model which had been designed at the end of the 1970s with a higher sectoral disaggregation and complexity in order to simulate policy responses to problems – such as oil price shocks – of the different EU Member States. The HERMIN models for the four cohesion countries have also been used to evaluate the impact of the Single Market on cohesion (Barry et al. 1998). In recent years, based on this experience and under the guidance of the Economic and Social Research Institute (ESRI) in Dublin, HERMIN models have been constructed for several European economies in transition: the Czech Republic, Estonia, Latvia, Romania, Slovenia and East Germany.6

For the Commission’s Second Report on Economic and Social Cohesion published in January 2001, the ESRI used the HERMIN models for the four cohesion countries to simulate the aggregated impact of the CSFs from 1989 to 2006.7 The results for Greece and Portugal, on the one hand, and for Spain and Ireland, on the other hand, are roughly comparable in size. The general pattern is an increasing impact on GDP with a peak in 1999 and a somewhat lower impact in 2006 following the decreasing size of Structural Funds relative to GDP (Figure 2). After 2006, when payments and the corresponding demand-side effects are assumed to stop, supply-side effects have a continuing impact of between 1 and 3 %. Unemployment rates are considerably lower than without the CSF in all countries, although these are more strongly linked to the demand-side effects than to the supply-side effects given the productivity effects of increased physical and human capital stocks (Figure 3).

The results from the QUEST II model and the HERMIN models for 2000-2006 both agree on the positive income and employment effects to be expected from the CSFs. However, they are difficult to compare directly and the results need to be interpreted in terms of the channels of CSF impact as well as the general fiscal and monetary channels that these models emphasise or neglect. The HERMIN simulation focuses, on top of the demand-side effects, on the supply-side effects through gains in productivity and competitiveness arising from the increased stocks in infrastructure and human capital. The QUEST II simulation confirms that these long-term effects, which improve the production structure of an economy and are the main objective of EU Structural Funds, continue to induce a higher level of GDP even when CSF payments are assumed to stop. However, the QUEST II simulation suggests that some of the initial positive effects of the CSF may be reduced by a deterioration of the trade balance and a certain crowding-out of private...
investment as a consequence of an appreciation of the real exchange rate and an increase in real interest rates.

3 The HERMIN model for East Germany

The HERMIN model for East Germany differs from the HERMIN models that have been developed for the cohesion countries and several central and eastern European countries since it describes the economic behaviour of a region rather than a national economy. Before the specificities of the East German model are described we will first look at the economic channels of the CSF and how the CSF influences the economic development. Then the HERMIN framework is discussed and the East German model is described briefly. In the last part of this section some simulation results are provided.

3.1 Economic impact channels of the CSF

Before any macroeconomic evaluation of the heterogeneous CSF can be carried out, the large number of individual investment programmes need to be combined into three aggregate economic categories:

- investment expenditure on physical infrastructure;
- investment expenditure on human resources;
- expenditure on investment aid to the private sector.

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

(1) EU transfers to domestic public authorities;
(2) Domestic public sector co-financing as set out in the CSF documents;
(3) Domestic private sector co-financing as set out in the CSF documents.

Since the inclusion of the private sector co-financing is problematic with regard to the size of dead-weight effects, they are ignored in the analysis. Certainly, there are indirect impacts of publicly financed CSF investment on private sector investment, and these are included in the HERMIN models.

CSF actions influence an economy through a mixture of supply and demand effects. Short term Keynesian demand effects can be captured by the appropriate rise in the components of domestic expenditure. These demand effects are of transitory importance and are merely a side-effect. Rather, the CSF interventions are intended to influence the long-run supply potential of the economy. These supply-side effects arise through policies aimed to:

- increase investment designed to improve the physical infrastructure as an input to private sector productive activity;
- increase in human capital, due to investment in training as a factor input in the private sector;
- direct assistance to the private sector to stimulate investment, thus increasing factor productivity and reducing sectoral costs of production and of capital.

Thus the CSF interventions are intended to increase the regional aggregate stock of human capital and public infrastructure 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 CSF improves the cost competitiveness of the region. In a certain sense, these policies create conditions where private firms enjoy the use of additional productive factors at no cost to them. 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 may be improved as a consequence. In all these ways, positive externalities may arise out of the CSF interventions.

Recent advances in growth theory have addressed the role of spillovers or externalities which arise from public investments 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, again, externalities arise when innovations in one firm are adopted elsewhere, i.e. when such innovations have public good qualities.

Two types of beneficial externalities are likely to enhance the standard neo-Keynesian (mainly expenditure) impacts of well designed public expenditure programmes on infrastructure, human capital and private investment. 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.

The HERMIN model for East Germany describes the economic behaviour of a region instead of a national economy.

The CSF actions influence the East German economy through a mixture of demand and supply effects. Whereas the demand effects are transitory the supply effects influence the long-run production potential through:

- improved physical infrastructure;
- increased human capital;
- higher private investment.

(6) See Kejak and Vava 1999 for the Czech Republic, Ciupagea and Manda 1999 for Romania, Simoncic, Kuzmin, Pajfar and Potoczni 1999 for Slovenia, all of them under the guidance of Bradley and Barry 1999. See Bradley, Kangur and Kearney 2001 for Estonia, Bradley and Kearney 2000 for Latvia and Bradley, Morgen-roth and Untiedt 2001 for East Germany (see section 3 on the latter). Bradley and Wright 1995 have also developed a HERMIN-type model for Northern Ireland.

(7) See Bradley 2000b. As also for the QUEST II simulations, "CSF" means only public EU and national funding, while private co-financing is excluded.

(8) This chapter draws heavily on Bradley, Morganroth and Untiedt 2001.

(9) Note that "domestic" public sector co-finance in the case of East Germany includes a large intra-German transfer from the West to the East.
investment, and enhancing the ability of indigenous industries to compete in the international market place. This is called "output externality" since it is well known that the range of products manufactured 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 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 case of fixed output, labour input is reduced. The prospect of such "jobless growth" is particularly serious in economies like East Germany, where the recorded rate of unemployment is already very 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. 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 level.

3.2 The macroeconomic modelling framework

If one element of the analysis comes from the research literature on the relationship between infrastructure, human capital and growth, a second element draws on the research literature on macroeconomic modelling. The theoretical underpinning of the HERMIN model is the two-sector small open economy model with a Keynesian role for domestic demand.\(^\text{(10)}\) The two-good model assumes two domestic sectors, one producing mainly internationally traded and the other mainly non-traded goods and services. Both sectors produce with constant returns to scale technologies and with sector-specific physical capital. The non-traded sector operates rather like a closed economy, where firms are price takers in the output market and price takers in factor markets. Thus, they maximise their profits subject to the production function constraint. In the traded goods sector businesses are a mixture of domestically owned local firms and externally owned multinationals. With limited market power, the pricing behaviour of the traded sector goods is a mixture of both price taking and price setting behaviour. The extension of the supply-side of the traded goods sector towards a more realistic model allows output of the sector to be determined both by domestic factor costs as well as by external and internal demand.

To be of use for the analysis for East Germany, the empirical HERMIN model needed to satisfy three requirements:

- The model had to be disaggregated into a small number of crucial sectors which allowed the key sectoral shifts in the economy to be identified and treated over the years of transition.
- The model had to specify the mechanisms through which the regional transition economy was inter-connected to the external world (mainly West-Germany). The external economy is a very important direct and indirect factor influencing the economic growth and convergence of East Germany, through trade of goods and services, inflation transmission, population emigration and inward foreign direct investment.
- The modelling framework had to recognise that a possible conflict might exist between the actual situation in East Germany, as captured in the HERMIN model calibrated with historical data, and the desired situation towards which the East German economy is evolving in the world of Economic Monetary Union and the Single European Market. There is also a very important phenomenon of the transition economy’s changing degree of integration into the structures of the European Union which must be taken into account during the modelling process.

Thus the HERMIN model framework focuses on key structural features of a transition economy with respect to such issues as:

1. economic openness, exposure to world trade, and response to external and internal shocks;
2. relative scale and characteristics of the traded and non-traded sectors and their development, production technology and structural change;
3. wage and price determination mechanisms;
4. the functioning and flexibility of labour markets with the possible role of international and inter-regional labour migration;
5. the role of the public sector and public debt, and the interactions between the pub-
lic and private sector trade-offs in public policies.

To satisfy these requirements, the HERMIN framework is designed as a macroeconomic model composed of four sectors: manufacturing (a mainly traded sector), market services (a mainly non-traded sector), agriculture and government (or non-market) services. The model is made up of three main blocks:

- a supply side (determining output, factor inputs, wages, prices, 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 expenditure and income distribution subcomponents generate the standard income-expenditure mechanisms of the model. Unlike QUEST, which has model consistent expectations the HERMIN model uses autoregressive expectations. However, the model also has neoclassical features, mainly associated with the supply sub-component. Thus, output in manufacturing is not simply driven by demand. It is also influenced by price and cost competitiveness, where firms seek out minimum cost locations for production.¹¹ 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.

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

In developing the empirical model for East Germany, several crucial issues arose that had to be addressed:

1. Although the collected official regional accounts for East Germany are in general of high quality, the data contain two mixed processes, namely transition issues that were evident during the first years after unification and then restructuring issues that started immediately after unification and became dominant after the initial transition processes moved towards completion. It was difficult and sometimes nearly impossible to disentangle these two processes while retaining a run of data adequate for model calibration.

2. The model had to recognise the regional character of East Germany and its dependence on the West German economy. Data requirements for the model-building and subsequent analysis and actual data availability did not always coincide.

As in the case of other existing HERMIN models for transition economies, the relatively short history of the transition process provides no or only rather short data time series. Many model parameters could only be estimated by applying calibration techniques on the basis of curve fitting on six annual data observations and checking the reliability of the outcome by comparison with the observed data and the parameters used for the models for Greece, Ireland and Portugal. Where this proved to be impossible, behavioural equations of the model were simplified. Because of a lack of data, East Berlin was not taken into account in the model. On the one hand, the recourse to calibration methods brings about some uncertainty as to the reliability of the model parameters, while on the other hand, the parameters might actually reflect much better the present situation of a rapidly changing economy.

The fact that East Germany is a region of a nation state is reflected in the model in many different ways, and makes it much simpler than the equivalent HERMIN models of nation states like Ireland and Portugal. The main direct East-West links are described below. However, it should be noted that these direct links also have indirect consequences for East-West interactions as well since the model functions as an integrated system of equations.

(11) See Bradley and FitzGerald 1988
East/West German linkages are mainly introduced through:
- GDP in manufacturing;
- output prices in manufacturing;
- wage rates in manufacturing;
- East-West migration flows.

Since the East German HERMIN model is an integrated system of equations all other aggregates are influenced as well.

The GDP in manufacturing is a modified "export-base" model, where external demand is a major driving force and the West German economy makes up 80 per cent of this demand. However, local (East German) absorption is also significant, as are real unit labour costs. Since so much of local absorption is driven by transfers from West Germany, this ex ante endogeneity effect is weak ex post. The most crucial "wedge" between East and West is real unit labour costs, since productivity movements in East Germany have been very different from those in West Germany.

Although a wider range of price transmission links were investigated for the manufacturing output prices, finally a direct West-East causal mechanism was imposed, where the Western inflation rate is simply passed on directly to the East. Experience in other EU regions (such as Northern Ireland) confirms this behaviour.\(^\text{12}\)

Concerning the wage rates in manufacturing, first the situation where there could be autonomous East German wage setting institutions was investigated. However, the manner of unification points to a fairly systematic process of wage level equalisation. We capture this by making the relative East-West wage differential a function of time, with the possibility that the convergence is sensitive to the East-West unemployment differential.

The driving force for the East-West migration flows is the relative East-West expected wage. This is a difficult equation to calibrate, so we imposed the condition that net flows cease when the relative East-West expected wage rate equals unity. We also take account of commuter flows, but leave these exogenous, since they have remained fairly steady over the years.

The expenditure and revenue sides of the East German public sector accounts are constructed in a way that is similar to an independent state. However, the expenditure and tax rates cannot be varied independently of the overall rates for Germany as a whole. This represents a direct East-West relationship that constrains East German behaviour.

3.3 CSF externalities incorporated into the model

The output externalities can be viewed as operating directly through the multinational and indigenous firm location and growth process that is so important in the case of the EU periphery and in the central and eastern European countries, and draws directly from the extensive literature surveyed in Bradley, Morgenroth and Untiedt (2001). The treatment of the manufacturing sector in HERMIN posits a supply side approach in which the share of the world's output being allocated to, or generated within, a peripheral country or region is determined by measures of cost competitiveness.\(^\text{13}\)

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

One simple way of describing this process is to link the growth of infrastructure and the increases in human capital to a modified version of the HERMIN behavioural equation that is used to determine manufacturing sector output. The theory underlying the macroeconomic modelling of a small open economy requires that this equation reflects both purely supply side factors, such as the real unit labour costs and international price competitiveness, as well as the extent of dependence of output on a general level of world demand, e.g. through operations of multinational enterprises. By contrast, domestic demand should play only a limited role in a purely traded sector, mostly in terms of its impact on the rate of capacity utilisation. However, the classification of the traded sector as being made up of manufacturing is somewhat imperfect, since manufacturing in any but extreme cases includes a large number of sub-sectors producing non-traded items. Hence, it can be expected that domestic demand play a more substantial role in this sector, possibly also influencing capacity output decisions of firms. Therefore the HERMIN East German model has a hybrid
supply-demand equation for manufacturing output (OT) of the form:

\[ \log(OT) = a_0 + a_1 \log(OW) + a_2 \log(ULCT/POT) + a_3 \log(FDOT) + a_4 \log(POT/PWORLD) + a_5 t \]

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

To take account of output externalities associated with infrastructure and human capital, the following two terms are added to the above equation:

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

where output in the manufacturing sector (OT) is now directly influenced by an increase in the stock of infrastructure (KGINF) and human capital (NTRAIN) over and above a baseline value. Thus, if the stock of infrastructure increases by 1 per cent relative to the baseline stock, output in manufacturing (OT) is boosted by \( \eta_1 \) per cent.

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

A factor productivity externality can be associated with improved supply conditions in the economy brought about as a result of investment in human capital and public infrastructure. These can be incorporated into HERMIN by endogenising the CES production function scale parameter, ‘A’ in connection with infrastructure and the effective input of labour in connection with human capital, which are now modelled as a function of the stock of public and human capital. Increases in the value of ‘A’ imply that for a given amount of inputs a higher level of output is produced.

Consider the production function

\[ Q = A^* f(L, I) \]

where \( A^* \) is the scale parameter, which can be considered to represent the state of technology, and \( L \) and \( I \) are the effective labour and investment inputs, respectively. The infrastructure factor productivity externality can be incorporated into the production process as follows:

\[ A_t = A_0 (KGINF_t / KGINF_0)^\eta \]

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

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

Suppose we assume that, prior to the implementation of the CSF, the existing number of trained members of the labour force, NTRAIN_0, is known. If the CSF increases are used to fund an additional number of trainees, giving a total of NTRAIN_t trained members of the labour force in year t, then the effective input of labour in the production function can be modified as follows:

\[ L_t = L_0 (NTRAIN_t / NTRAIN_0)^\eta \]
where \( L_0 \) is the effective labour input prior to CSF. Introducing the increase in the human capital stock as above is equivalent to inserting a labour-embodied technical progress term. In the empirical model, this externality is incorporated into the treatment of both the manufacturing and service sectors.

3.4 Simulation results of the overall impact of the CSF on East Germany

The CSF expenditures (without private co-financing) initially make up nearly 2 % of GDP in East Germany, but decline gradually to around 1.2 % in the year 2006 (Figure 4). So, there is likely to be a significant demand side impact simply due to the expenditure of Structural Funds. For mere methodological reasons the CSF expenditures are assumed to cease after 2006. Since the core of the CSF interventions is to influence the supply-side of the East German economy output, factor productivity externalities are incorporated into the HERMIN East Germany model which serve to link the CSF directly with the supply side of the economy. Given that the empirical literature is not clear about the appropriate magnitude of the externalities, different values have been used to carry out a sensitivity analysis (see Bradley, Morgenroth and Untiedt 2001 for details). The results shown below result when medium elasticities (output elasticity equals 0.1 and the factor productivity elasticity is set to 0.05) are used, which are at the lower bound of those empirically observed.

In Figure 5 we show the impact of the CSF on aggregate GDP (as a percentage change relative to the no-CSF baseline), and on the unemployment rate (as a difference relative to the no-CSF baseline). This simulation captures the direct demand-side impacts as well as additional supply-side impacts that are associated with the improvement in infrastructure and human resources.

By the year 1999 (the terminal year for the 1994–99 CSF II period), the level of GDP has been raised by just over 4 % relative to the no-CSF baseline forecast, and the unemployment rate is lower by over 2 percentage points. Similar beneficial impacts endure until 2006 (the terminal year for the current CSF III period). After 2006, it is assumed that all CSF investment expenditures fall to zero, and Figure 2 shows that the beneficial impacts on GDP continue, albeit at a lower rate, but that the unemployment rate quickly reverts to the baseline value.
Some sectoral impacts of the CSF are shown in Figure 6. Since construction activities take place within the market services sector (ON), GDP in services increases significantly as CSF projects are implemented. The benefit to GDP in manufacturing (OT) comes mainly from the supply-side, and – in contrast to market services – this endures even after the termination of the CSF in 2006. There is a modest increase in public sector output (OG), mainly due to the implementation of training schemes, but this terminates abruptly after the year 2006.

Some of the supply-side impacts of the CSF on manufacturing are shown in Figure 7. First it is seen that investment in manufacturing is about 6 to 10% higher in the period 1994 to 1999 and around 6% higher in the period 2000 to 2006 and declines to 3% in 2010. Furthermore it is seen that labour productivity increases by about 1.5% over the baseline. Since the output effect is higher than the labour productivity effect we observe an employment effect of around 2% over the baseline.

Finally, Figure 8 shows that the CSF improves the East German regional deficit, mainly because of the boost to the region from CSF transfers from outside the region (EU and West Germany). In addition, the regional trade balance improves by about 0.5% of GDP, but reverts to its baseline value after 2006.

Taken together the macro experience with the East German HERMIN model shows that the CSF has a significant impact during the period 1994 to 2006 through a mixture of demand-side effects and lasting effects through the improvement of the supply side conditions in East Germany.

4 Conclusions and outlook

Compared to other possible methods to evaluate the aggregate impact of EU Structural Funds, macroeconomic models have the important advantages of identifying the counterfactual situation (i.e. the situation without Structural Funds) and of simulating the interplay of macroeconomic variables. Looking at the use of macro-modelling for the evaluation of EU Structural Funds in general, and the more specific case of East Germany, there has been considerable progress during the 1990s on several aspects:

- The general focus has shifted from the standard Keynesian models to models which also include the long-term supply-side effects of Structural Funds, given that these are the main objective of EU assistance under Objective 1. Simulations with models like QUEST II and HERMIN which include supply-side effects are thus less subject to the often expressed “Lucas critique” meaning that predictions for the future can not be based on observations in the past due to policy-induced structural change. To emphasise this point the models are explicitly designed in a way that

Although East Germany also received Structural Fund assistance from 1991 to 1993, an evaluation for these years would be difficult because of the unstable transition of the economy.
policy-induced structural changes are taken into consideration that lead to an evolving system of equations.

- The HERMIN model series has widened the geographical coverage from the four cohesion countries to several transition economies, including the specific case of East Germany as a large region which is part of a bigger economy. If this were to continue and a complete set of models were developed for present and future main beneficiaries of Structural Funds, such as the Mezzogiorno and the remaining candidate countries, the possibility of sufficiently comparable and, possibly, aggregated results for several or all countries would open up.

- In dealing with the specific data problems of transition economies, the methodology of estimating model parameters in the HERMIN models has shifted from only "pure" econometrics to a combination of curve fitting with calibration techniques and comparisons with present EU cohesion countries (Greece, Ireland and Portugal). This seems to be an interesting approach for analysing any catching-up economy in view of the rapid structural change which is usually not captured by econometric estimations that are based on long time series.

If we compare the three objectives of evaluation mentioned at the beginning of this article with the state of the art of macroeconomic modelling for EU Structural Funds as described in sections 2 and 3, several observations can be made:

1. Until now, macroeconomic models have not yet been able to assess the relative efficiency of Structural Funds to achieve the objective of reducing income disparities compared to alternative policies such as different wage policies, lower taxes or structural reforms. Although in principle desirable, it remains doubtful whether models can be sufficiently precise to carry out such an exercise. But it should nevertheless be possible to simulate different policy scenarios through variations in the baseline scenario which would demonstrate the importance of the economic policy framework for the impact of Structural Funds. In the case of East Germany model results on the impact of Structural Funds would certainly vary considerably under different assumptions of wage convergence to West Germany.

2. The situation is still unsatisfactory with regard to guidance for decision-makers on how to spend Structural Funds in the most efficient way. In order to do so, macro-models would have to be able to indicate the optimum structure of spending between categories such as infrastructure, human resources and business environment, and even within each of these categories, i.e. for example training or R&D. However, given the state of the art of the rather recent endogenous growth theory, empirical results on the growth effects of public expenditure are still rather uncertain and vary considerably. Until research in this area has not advanced further, using macro models towards in this way could contribute to misleading decisions on public expenditure.

3. Finally, macro models can indeed give account to taxpayers that Structural Funds have positively contributed to the sustained growth of the main beneficiaries. Although the magnitude of effects varies for different models, this variation should be seen as an asset since it provides some certainty about the range of effects under different assumptions and illustrates the different channels of impact. However, when comparing the results between countries, in particular between those countries where Structural Funds are similar in size, conclusions on the institutional efficiency of spending can not be drawn. Differences are mostly due to different features of the economies, reflected in the model parameters as for example the openness to trade, and not to the organisation of spending which models implicitly assume to be perfect.


