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The Impact of EU Regional Support on Growth and Convergence in the European Union*

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Abstract

The evidence presented in this article suggests that EU regional support has a significant and positive impact on the growth performance of European regions. Moreover, there are signs of a change in the impact of this support in the 1990s, indicating that the major reform of the structural funds undertaken in 1988 may have succeeded in making EU regional policy more effective. However, the results also indicate that the economic effects of such support are much stronger in more developed environments, emphasizing the importance of accompanying policies that improve the competence of the receiving environments.

Introduction

Greater equality across Europe in productivity and income has been one of the central goals of the European Community since the early days of European economic integration, and various policy measures have been introduced to help achieve this goal (the 'structural funds'). For a long time it appeared as if the regions of Europe were on a converging path and, hence, that the existing policies had the desired effect (e.g. Molle, 1980). More recent evidence has, however, challenged these perceptions by showing that the ten-

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dency towards convergence came to a halt in the beginning of the 1980s (Neven and Gouyette, 1995; Fagerberg and Verspagen, 1996). In the decade that followed, very little regional convergence occurred within individual EU Member States (Cappelen *et al.,* 1999; Commission 1996, 2001). To the extent that there has been any convergence, it appears to have been mainly at the country level (catch-up by the southern member countries that joined the Union in the 1980s). These findings beg new questions about the effectiveness of existing policies.

The EU structural funds went through a major reform in 1988. The objective was to make the funds more effective in reducing the gap between advanced and less-advanced regions, and strengthening economic and social cohesion in the European Community. The financial resources allocated to these funds were also significantly increased. The reform of European regional policy, the increase in the budget and the recent slowdown of convergence all underline the need for a thorough assessment of the policy outcomes. The current enlargement of the European Union, and the possible role that regional policy may play in an enlarged Union, further underline the need for an improved understanding of how these policies work and what the long-run effects are.

So far, such assessment has been mainly descriptive (e.g. Commission, 1997; Bachtler and Turok, 1997; Heinelt and Smith, 1996; Staeck, 1996), or based on simulations of large macroeconomic models (Commission, 1999, 2001). The first approach consists primarily of outlining what type of investments have been made using the funds, as well as examining the characteristics and performance of the regions that have received the investments. While such a descriptive undertaking certainly yields useful insights into the working of policy, and helps us to distinguish between successful and unsuccessful cases, it cannot be seen as evidence of causality. Moreover, in most cases the sample of regions included in such analyses is too small to warrant any general conclusions. The second approach, i.e. macroeconomic simulation, has the advantage of providing more exact estimates of the growth effects of regional support. However, such estimates are arrived at in an indirect manner (as a shift in investment, for instance), rather than as an assessment of the direct outcome of changes in specific policies or support schemes. Furthermore, the estimates thus obtained depend crucially on the specific assumptions on which the model is based. Hence, it is possible that the results that come out of such simulations may depend more on the hypotheses underlying the model than on, say, what happens to regional support schemes.

In this article, we will try to estimate the long-run effects of European regional support through the structural funds in a more direct manner, with particular emphasis on the extent to which the 1988 reform has succeeded in

making European regional policy more effective. In previous work, we have shown that differences in economic growth across European regions can be reasonably well explained by an approach that focuses on innovation activities in the region, the potential for exploiting technologies developed elsewhere and complementary factors affecting the exploitation of this potential (Fagerberg and Verspagen, 1996; Fagerberg *et al.,* 1997; Cappelen *et al.,* 1999). What we will do in this article is to include regional support through the structural funds in an analysis of growth and convergence in the European Union in the 1980s and 1990s, based on this approach. In this way we will be able to make a joint assessment of the impact of regional support and other growth-enhancing (or growth-retarding) factors at the regional level.

The structure of the article is as follows. In Section I we present new evidence on growth and convergence in the European Union in the 1980s and 1990s. The analysis confirms that there is more convergence at the national level (between countries) than at the regional level (within countries), and more for a group of EU member countries that includes the entrants of the early to mid-1980s than for the narrower group of countries that had joined earlier. In Section II we present some statistics on EU regional support for our sample of regions in the same period. It is shown that the degree of support has increased significantly over time. However, the allocation of such support does to some extent depend on factors that may have an effect on regional growth independently of the support itself, and this arguably complicates the analysis. We discuss the implications of that in Section III, which presents the model to be used in the analysis, and considers how it may be applied to the existing data.

For example, the theory argues that lagging regions may have a high potential for growth due to a backlog of technological knowledge developed in advanced regions. However, because the lagging regions are also the regions that receive most support from European sources, it may be difficult to separate the effects of 'catching-up' and regional support. We suggest that choosing an estimation method that combines cross-sectional and time-series information may reduce these problems. Section IV presents the results. These indicate that EU regional support has a significant and positive impact on the growth performance of European regions. Moreover, there are signs of a change in the impact of this support in the 1990s, indicating that the major reform of the structural funds that was undertaken in 1988 may have succeeded in making EU regional policy more effective. The results also indicate that the economic effects of such support are much stronger in more developed regions, emphasizing the importance of the receptiveness of the receiving environments. The final section concludes and discusses the implications for policy.

I. Regional Convergence?

It is by now well established that the distribution of regional incomes per capita in Europe became more equal after the Second World War (Molle, 1980; Molle and Cappellin, 1988). However, this convergence in regional incomes seems to have slowed or come to halt after 1980 (Fagerberg and Verspagen, 1996; Cappelen *et al.,* 1999). This is especially the case for the countries that were already members in the 1970s. But, during the 1980s, three relatively poor southern European countries joined the Union and, as might be expected, this led to changes in the European growth pattern (including convergence). More recently the EU has been enlarged by three relatively rich countries (Austria, Finland and Sweden) as well as a relatively poor one (Eastern Germany), and this may also have affected European growth and the regional distribution of income in the EU.

This shows that, when studying dispersion of regional incomes in the EU over time, it is important to adjust for significant changes in the number of regions within the EU. We have chosen to confine our study to the countries that comprised the Union before the entrance of new members in the 1990s (with a definition of Germany that is nearly identical to the previous Western Germany). However, due to a lack of regionalized data, we were not able to include the three smallest EU member countries: Denmark, Ireland and Luxembourg.[1] Regions are defined at the NUTS 1 or NUTS 2 level depending on availability of other types of data needed in the empirical analysis. Where we include NUTS 1 regions, these are generally comparable in size to the NUTS 2 regions we use. Incomes are made comparable by using current purchasing power parities (based on ESA95[2]).

Table 1 presents an overview of the dispersion of GDP per capita in the European Union for selected years between 1980 and 1997. Two different measures are included, the (regional) standard deviation for Europe as a whole,[3] and the regional standard deviation within countries[4] (i.e. adjusted for cross-country differences in GDP per capita).[5] The former is a measure of the de-

[1] These three countries would in any case have entered as single regions but since, as is customary in econometric analyses on pooled cross-country data sets, we use country-specific dummy variables to account for the impact of possible unidentified country-specific factors, most of the growth of these countries would by definition be accounted for by these dummies.

[2] European System of Accounts (ESA, 1995); Eurostat, Luxembourg (1996). Hence these data are not directly comparable to the data we have used previously (e.g. Cappelen *et al.,* 1999).

[3] The regional standard deviation is calculated as the standard deviation of the log of relative regional GDP per capita (regional GDP per capita divided by the EU average for the same year).

[4] Standard deviation within countries is calculated as the standard deviation of the log of relative regional GDP per capita (regional GDP per capita divided by the country average for the same year).

[5] To the extent that commuting across regional borders is frequent (living in one region and working in another), GDP per capita numbers may present a biased picture of income and/or productivity. The European Commission (2001) argues that 'problems of commuting … are significant only in a few cases' (p. 10). Anyway, as long as this phenomenon does not change much over time, it will not invalidate the analysis presented below of the changes in regional dispersion.

Table 1: Dispersion of Regional GDP per Capita in Europe, 1980–97

	1980	*1985*	*1990*	*1997*
Total sample (105 regions)				
Standard deviation (std.)	0.31	0.31	0.30	0.27
Std. within countries	0.19	0.19	0.19	0.19
Actual sample (95 regions)				
Standard deviation (std.)	0.32	0.31	0.31	0.28
Std. within countries	0.19	0.19	0.20	0.20
Actual sample less Greece, Portugal and Spain				
Standard deviation (std.)	0.22	0.22	0.23	0.24
Std. within countries	0.20	0.20	0.20	0.21

Note: GDP figures based on current PPS (ESA95).

gree of regional dispersion in the EU as a whole (irrespective of which country the region belongs to), the latter indicates to what extent the change in the former reflects changes in dispersion between regions within individual member countries (the measures are normalized so that the numbers are comparable across years). We present indices of regional dispersion for three different samples, the total sample, the sample used in the econometric analyses presented later in this article (actual sample), and a reduced sample that excludes the three Southern member countries that joined during the 1980s. The total sample contains all regions from the nine countries included in our investigation, and the actual sample is slightly smaller due to lack of data for certain regions for some of the variables included in the econometric analysis presented in Section III.[6]

The table shows that regional dispersion for the sample as a whole changed very little between 1980 and 1990. But there appears to have been a decrease in regional dispersion (i.e. convergence) after 1990. However, this does not hold if the three new southern members are excluded from the sample. In fact, in this case there appears to be a slight trend towards increased differences – or divergence – over time. Moreover it does not apply to dispersion within countries (irrespective of whether the three new entrants are included or not). Hence, these numbers show that the decrease in regional dispersion for the sample as a whole after 1990 is entirely accounted for by the catch-up of the three new member countries towards the European level. Within countries there is, on average, no convergence.[7]

[6] The difference in sample size consists of the Dutch regions and some individual regions from other countries (see the Appendix for details).

[7] See also the analysis of this issue in Commission (2001), which also points out that there is little, if any, convergence across regions within individual EU member countries. However, the analysis presented here

II. EU Regional Support

How is this to be explained, given the quite extensive regional support schemes at work in Europe aimed at fostering regional convergence? As an introduction to the econometric analysis that follows, we will in this section present some key information on EU regional support for the sample of regions covered by our analysis.

Until the 1970s, regional policy[8] in Europe was a domestic matter. However, several factors (including the proposed enlargement to include the UK and Ireland and contemporary initiatives for a deepening of European integration), led to a greater focus on regional policy at the European level, and in 1975 a separate fund (ERDF – the European regional development fund) was created to help alleviate the principal regional imbalances within the Community. Although modest at first, EU regional support through the structural funds has grown in importance over the years and today is one of the key policy areas in the European Union. An important step in that process came in 1988 when the structural funds went through a major reform following the enlargement of the Community to include three relatively poor countries from the south (and the plans for 'a single market'). The main objective of the reform was to make the funds more effective in reducing the gap between advanced and less-advanced regions, and strengthening economic and social cohesion in the Community. The financial resources allocated to these funds were also significantly increased. In this new system, several 'objectives' were formulated. For the purpose of this article, three of these objectives are of special importance:

- objective 1, aimed at regions lagging behind in terms of GDP per capita, defined as regions with GDP per capita lower than 75 per cent of the Community average;
- objective 2, aimed at regions in industrial decline, as indicated by (high) unemployment and (low) employment growth;
- objective 5b, aimed at rural and agricultural regions, as indicated by the share of employment in agriculture and GDP per capita.

The other objectives (3 and 4 aimed at unemployment, and 5a aimed at common agricultural policy) cannot easily be attributed to individual regions, and will not be taken into account here. Thus the analysis that follows considers

covers a longer time span (1980 compared to 1988 as the starting year). Moreover, we use a consistent classification of regions, while the EU study uses the NUTS 2 level without adjusting for the changes in the classification system over time, which implies that they cannot properly distinguish between changes in dispersion and changes stemming from classification changes (Commission, 2001, Table A3). Hence the results presented here should be more robust.

[8] For analyses of regional policy in the EU, including the background and consequences of its reforms, see Begg and Mayes (1993), Begg (1997) and Bache and George (2001).

only support that can be clearly identified with individual regions and which may be assumed to have an impact on why growth differs across regions within a country. Moreover, it should be emphasized that the numbers presented below aim to illustrate the amount of support that the 'typical' region of our sample(s) receives. Hence, the numbers refer to the average region (the mean value of the variable for the regions of a country or a group of countries). These numbers may differ slightly from official statistics for entire countries or the EU as a whole. For instance, regions that receive extensive support are often poorer and less populous than those that receive little or no support, with the consequence that the mean value (over a sample of regions) of EU regional support as a share of GDP will tend to be slightly higher than more aggregated statistics (calculated for entire countries or the EU as a whole).[9]

Figure 1 gives an indication of the magnitude of regional support to the average region of our sample before and after the 1988 reform of the funds. During the period 1980–84 the average region in our sample received European regional support equal to around 0.2–0.3 per cent of its GDP.[10] In the years that followed (1985–87), average regional support increased to 0.4 per

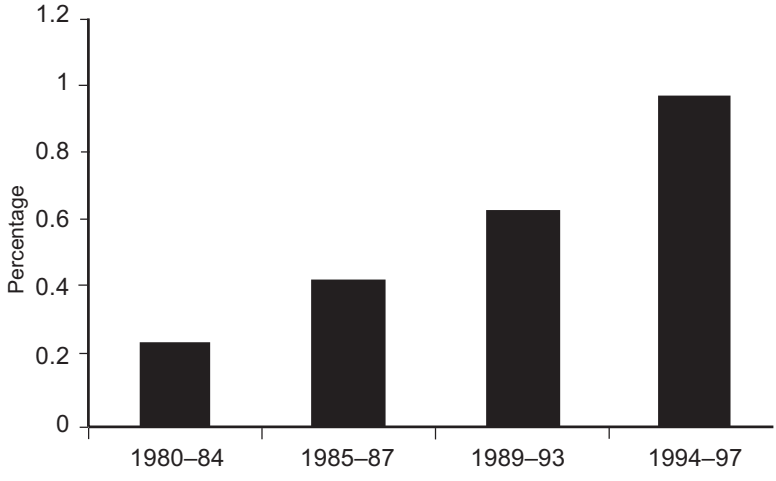

Figure 1: EU Regional Support as a Percentage of GDP, Average EU Region
Source: Estimates by the authors based on data from Eurostat, *Regions, Statistical Yearbook,* various issues and Commission (1997, 2000).

[9] Another source of discrepancy lies in missing values for some regions (or countries) included in the more aggregated statistics.
[10] Data for the period 1980–87 include support (paid grants) through the 'guidance' part of the European agricultural guidance and guarantee fund (EAGGF), financing structural adjustments in rural areas, and the European regional development fund (ERDF), aimed at correcting for the principal regional imbalances in the Community. The latter (ERDF) was the most important – about five times that of the former.

cent, largely because the Community now had two relatively poor new members (Spain and Portugal), who both qualified for extensive regional support. After the reform (1989–93) the mean support level increased to around 0.6–0.7 per cent of GDP, i.e. more than twice the level attained a decade earlier. In 1993, a new reform of the structural funds was agreed that increased the level of support, especially for objective 1 regions. As a result, in the following years (1994–97), EU regional support as a percentage of GDP approached 1.0 per cent on average. The poorer member countries also benefited from the cohesion fund, which was agreed in 1992 and became operative in the following year. Support through these funds mostly went to large transport or environmental projects spanning several regions, and a regional breakdown is not available. Moreover, compared to other types of regional support, its magnitude is relatively modest. For instance, for Greece, Portugal and Spain between 1994 and 1997 (the only countries in our sample eligible for support through the cohesion fund), EU regional support through objectives 1, 2 and 5b was between six and ten times that of support through the cohesion fund.

Table 2 gives an overview of the distribution of EU regional support across objectives and countries for the period following the 1988 reform. As the table shows, during this period objective 1 support was by far the most important. The countries that received the largest amount of support (relative to GDP) were Portugal and Greece, 2.9 per cent and 2.2 per cent of regional

Table 2: EU Regional Support as a per cent of GDP, Average over Regions in our Sample, 1989–93

	Ob. 1	*Ob. 2*	*Ob. 5b*	*Total EU*	*National*	*Private*	*Sum*
Belgium	0.000	0.024	0.004	0.028	0.034	0.010	0.073
Germany	0.000	0.012	0.007	0.020	0.028	0.011	0.059
Greece	2.229	0.000	0.000	2.229	1.136	0.191	3.556
Spain	0.560	0.071	0.037	0.667	0.537	0.306	1.510
France	0.000	0.040	0.041	0.081	0.114	0.072	0.267
Italy	0.434	0.026	0.026	0.484	0.434	0.213	1.131
Netherlands	0.000	0.012	0.000	0.012	0.024	0.005	0.041
Portugal	2.863	0.000	0.000	2.863	1.685	1.346	5.894
UK	0.080	0.073	0.004	0.157	0.164	0.083	0.404
Mean over regions	0.599	0.035	0.021	0.655	0.440	0.205	1.300
Mean over regions, excl. Greece, Portugal and Spain	0.139	0.034	0.022	0.194	0.192	0.099	0.485

Source: Calculations by the authors based on data from Commission (1997).

GDP, respectively. Spain (0.7 per cent) follows at some distance, then Italy (0.5 per cent). Thus, it is clear that Southern European regions benefited proportionally more from European regional support than regions in other parts of Europe.

For this period we also have data on national public and private matching funds (the columns 'National' and 'Private'). The provision of these funds is in fact a prerequisite for obtaining structural funds at all. On average, national public and private matching funds are about as large (in terms of budget) as the European funding. Public matching funds are about two-thirds of total matching funds. Although in the present article, we will not explicitly take into account the role played by the national public and private matching funds, it is worth noticing that such matching funds are indeed important for recent EU regional policy, as one of the main purposes of the 1988 reform was to strengthen the co-ordination between the regional policy of the Member States and the EU structural funds on long-term plans and objectives.

How 'tight' is the connection between the criteria underlying the various objectives and the actual distribution of funds across regions? This is an interesting question in itself, but in this article it takes on added significance because, as pointed out previously, some of those criteria reflect economic variables that may affect growth independently of the support. To explore this connection in more detail, we performed a cluster analysis with the explanatory variables that we will use in later sections (see Section III) as the inputs. These were:

- industrial structure (the shares of employment in agriculture and industry, respectively, in total employment);
- long-term unemployment as a share of the total labour force;
- physical infrastructure (kilometres of motorways per square kilometre);
- population density (the number of inhabitants per square kilometre);
- GDP per capita in the initial year; and the
- R&D intensity, defined as business enterprise R&D personnel as a percentage of total employment.

European regional support was broken down by objective (1, 2, 5b) in this analysis. We arbitrarily fixed the number of clusters to five, and applied a so-called K-means clustering algorithm. All variables were standardized before entering in the clustering algorithm.

We obtained one small cluster of two regions, to be disregarded in the following, and four larger clusters. The characteristics of the four larger clusters are documented in Table 3. Note that because the data were standardized, a value of zero corresponds to the sample mean, and plus (minus) one corresponds to one standard deviation above (below) the mean. Cluster 1 is a clus-

Table 3: A Cluster Analysis of European Regions 1989–93

Variable	*Clusters*			
	1	*2*	*3*	*4*
	'Little Support'	*'Objective 1'*	*'Objective 2 & 5b'*	*'Intermediate'*
No. of regions	19	34	10	40
Agriculture	–0.74	1.05	–0.47	–0.38
Manufacturing	0.51	–0.61	0.99	0.14
Unemployment	–0.49	0.45	0.33	–0.35
Infrastructure	1.53	–0.64	–0.11	–0.20
Obj. 1 support	–0.63	1.21	–0.55	–0.59
Obj. 2 support	–0.21	–0.48	2.62	–0.12
Obj. 5b support	–0.40	–0.48	0.94	0.39
Population density	0.39	–0.25	–0.23	–0.23
GDP per capita	1.10	–1.03	–0.09	0.33
R&D	1.42	–0.82	–0.25	0.08

ter of 19 rich regions that receive little regional support from EU sources. We label these the 'little support' cluster. These regions do a lot of R&D and have a well-developed infrastructure. Unemployment is low. Cluster 2 is the polar case. It consists of 34 poor regions that receive relatively high Objective 1 support. These regions are largely agricultural, with a low level of R&D, but a high level of unemployment. The two remaining clusters (3 and 4) both have medium income. Cluster 3 is a small one (10 regions) characterized by a very high level of objective 2 support, and relatively high objective 5b support. As might be expected by the nature of objective 2 support, these regions have relatively large manufacturing sectors. The final cluster (4), labelled 'intermediate', is a group of peripheral regions, characterized by relatively poor infrastructure and low population density, but with a level of income that on average is too high to attract much objective 1 support. However, these regions do attract some objective 5b support.

The conclusion of this analysis is that the three forms of European regional support that we distinguish after the 1988 reform are clearly aimed at different types of regions. One can indeed speak of a 'typical objective 1 region', and the same holds to some extent for the two other objectives. Hence the connection between the official criteria and the actual distribution is relatively 'tight'. As mentioned above, this makes it more difficult to estimate the impact of the support, since the variables that these criteria reflect may affect growth independently of the support. However, before we discuss the implications of this further, we need to present our explanatory framework and consider how the variables mentioned above fit into that.

III. Economic Growth, Innovation Diffusion and Regional Support

Any explanation of growth differences needs theoretical underpinning. Economic analyses of differences in growth across countries or regions have mostly been based on one of two perspectives. The first, based on the traditional neoclassical theory of economic growth (Solow, 1956), relies on the assumption that technology is a public good, available to anyone free of charge. This perspective puts the emphasis on capital accumulation as the main vehicle for reducing differences in productivity across countries or regions. Moreover, this is assumed to happen more or less automatically, as long as markets are allowed to work freely. The other, competing, perspective puts the main emphasis on innovation and diffusion of technology as the driving force behind differences in growth (Nelson and Phelps, 1966; Fagerberg, 1987; Barro and Sala-i-Martin, 1995, ch. 8). This perspective is based on a totally different view of technology, emphasizing its public as well as private character, and the complementarities with other factors affecting the growth process. This leads to the hypothesis that, without the ability to develop such complementary factors, countries or regions are likely to fall behind rather than catch up.

Previous research has shown that the predictions of the traditional neoclassical model do not fit regional growth very well (see, e.g., Sala-i-Martin, 1996). Moreover, the assumption of technology as a (global) public good does not carry much empirical support or intuitive appeal. On the contrary, decades of empirical research on the creation and diffusion of technology within and across country borders has shown that technology is often a very local affair, embedded in firms, clusters of firms, regions and countries (Dosi, 1988). Although diffusion may – and does – take place, successful cases normally involve a host of other, supporting factors (Fagerberg, 1994). These are facts that any theory that wants to throw light on the convergence–divergence phenomenon has to account for.

In previous work we have analysed differences in growth performance with the help of a so-called 'technology-gap model' (Fagerberg, 1987, 1988; Verspagen, 1991). This model, based on the second of the two perspectives outlined above, focuses on the impact of differences across countries in innovative efforts, the potential for imitation and the capacity to exploit advances in technology for differences in growth performance. This approach, based essentially on Schumpeterian thinking,[11] is consistent with the existing knowl-

[11] Although Schumpeter did not extend his analysis of innovation diffusion to the international economy, this seems to be quite a natural extension to make. Indeed, the so called 'neo-technological' trade theories of the 1960s were heavily inspired by Schumpeter (Posner, 1961; Vernon, 1966). More recent analyses of international economic developments drawing on Schumpeterian insights can be found in Dosi *et al.* (1990) and Grossman and Helpman (1991). For a discussion of the link between Schumpeter's work and post-war theoretical and applied work on growth and trade, see Fagerberg (2002, Introduction).

edge on innovation and diffusion processes. Many of the assumptions and derived predictions can also be made consistent with 'new growth theories' that focus on innovation diffusion as the driving force of capitalist development (Romer, 1990; Grossman and Helpman, 1991). Empirical work on cross-country samples based on this perspective confirms the importance of national technological capabilities (and other supporting factors) for successful catch-up (for overviews, see Fagerberg, 1994, 2002b). Thus, real world catch-up is far from the easy, mechanical process envisaged by the traditional neo-classical approach in this area.

What we will do in the following is to apply this perspective to regional growth rate differences within Europe.[12] Assume that the level of productivity in a region (Q) is a multiplicative function of the level of knowledge diffused to the region from outside (D), the level of knowledge created in the region (N), the region's capacity for exploiting the benefits of knowledge independently of where it is created (C), and a constant (Z):

$$Q = ZD^{\alpha}N^{\beta}C^{\tau}, \text{ where Z is a constant} \quad (1)$$

By differentiating and dividing through by Q, letting lower-case letters denote growth rates:

$$q = \alpha d + \beta n + \tau c \quad (2)$$

Assume further, as is common in the diffusion literature, that the diffusion of external knowledge follows a logistic curve. This implies that the contribution of diffusion of externally available knowledge to economic growth is an increasing function of the distance between the level of knowledge appropriated in the region and that of the region on the technological frontier (for the frontier region, this contribution will be zero). Let the total amount of knowledge, adjusted for differences in size of regions, in the frontier region and the region under consideration be T_f and T, respectively:

$$d = \mu - \mu\,(T / T_f) \quad (3)$$

By substituting (3) into (2) we finally arrive at:

$$q = \alpha\mu - \alpha\mu\,(T / T_f) + \beta n + \tau c \quad (4)$$

Hence, following this perspective, regional growth may be seen as the outcome of three sets of factors:

- the potential for exploiting knowledge developed elsewhere (diffusion);
- creation of new knowledge in the region (innovation); and
- complementary factors affecting the ability to exploit the potential entailed by knowledge independently of where it is created.

[12] The presentation of the model draws on Fagerberg (1988).

There are two major challenges when applying this perspective. The first has to do with finding indicators of innovation and the potential for diffusion, the second with identifying and measuring the 'complementary factors'. For innovation we use R&D intensity, defined as business enterprise R&D personnel as a percentage of total employment.[13] We expect a positive impact of this variable. For diffusion potential we use, as is customary in the literature, the initial level of GDP per capita in the region (log-form). The higher this level, the smaller the scope for imitating more advanced technologies developed elsewhere. Hence, the expected impact of this variable is negative. Regarding complementary factors, there are many candidates that can be defended theoretically and that we would have liked to take into account, from variables related to various types of investments (education, infrastructure and physical capital) to structural factors of various sorts. However, data are scarce, especially among the former.

The 'complementary' variables that we were able to take into account were as noted:

- physical infrastructure (kilometres of motorways per square kilometre);
- population density (the number of inhabitants per square kilometre);
- industrial structure (the shares of employment in agriculture and industry, respectively, in total employment);[14] and the
- long-term unemployment (that is, duration of more than one year, as a share of the total labour force).

Among these, we would expect the first two to have a positive impact on technology diffusion, since both a more developed infrastructure and a higher population density increase the profitability/reduce the cost of introducing new technology. Regarding industrial structure, it is one of the standard results in the existing empirical literature on regions that this is of significance. In particular, a high reliance on agriculture has been shown to be detrimental to regional growth (Fagerberg and Verspagen, 1996), among other things because of low technological opportunities and slow growth of the market. On the share of 'industry' in total employment, the expectations are less clear. Traditionally this sector – particularly manufacturing – has been regarded as an 'engine of growth' (Kaldor, 1967). However, technological progress in recent decades has been more geared towards services than industry, and many

[13] All data for the variables described below are taken from the Eutostat Regio database and measured mid-period (1990). In some cases, missing data were filled in by interpolation. R&D data for the UK in the first period were estimated on the basis of less aggregated data from that period and a regional breakdown from a later year. Regions with zero R&D in the second period and no account for the first period were assumed to have zero R&D in that period as well.

[14] Industry as used here includes fuel and power, manufacturing and construction. The remaining part of total employment when agriculture and industry are deducted is services, which therefore cannot be included as a separate variable.

traditional industries have been characterized by slow growth. Finally we include the level of unemployment as a possible complementary factor. We interpret this as a measure of the cohesion of the broader social and economic system in the region. The higher the share of the labour force that is excluded from work on a long-term basis, the less well this system works. Hence it is an indicator of institutional failure, and as such it might be expected to have a negative impact on growth. For instance, it may hamper inflows of risk capital and qualified people, and encourage outflows, as empirical research in this area indeed suggests (Fagerberg *et al.,* 1997). Long-term unemployment also leads to degradation of skills and lack of learning by doing in parts of the workforce.

To this framework we then add the regional support from the EU as another possible growth-inducing factor. Such support has both a short-run (demand) and a long-run (supply) effect. While the former occurs more or less instantaneously, the latter may take several years to materialize. Since it is the latter that is of interest here, we have designed the test in a way that is consistent with relatively long lags between the investment and its economic effects.[15] However, as noted previously, the way in which this support is allocated to regions poses a problem for the estimation. As pointed out in Section II, the most important form of support (objective 1 support) is allocated to regions on the basis of GDP per capita, which is also one of our explanatory variables. In addition, objective 2 support is allocated partly on the basis of unemployment rates, while objective 5b support is allocated partly on the basis of the share of employment in agriculture. Again, both variables are part of our set of explanatory variables. Thus it comes as no surprise that the three forms of European regional support are closely correlated with various structural characteristics of regions, among which are the main variables of interest in our empirical model as set out above (Table 4).

As the table shows, it is the close relation between European structural funds, on the one hand, and GDP per capita and the share of agriculture in

Table 4: Correlation Coefficients between Selected Explanatory Variables in our Model for the Period 1989–97

	European Support (% of GDP)	*GDP per Capita, 1989*	*Long-term Unemployment, 1989*
GDP per capita, 1989	–0.79		
Long-term unemployment, 1989	0.11	–0.31	
Share of agriculture, 1989	0.81	–0.73	0.04

[15] In both periods we use data for regional support from the first half of the period, 1980–84 and 1989–93, as independent variables.

employment, on the other hand, which is most likely to pose problems in the estimation. The implication is that, due to this high degree of correlation, it may be difficult to separate econometrically – especially in a cross-sectional dimension – the effect on regional growth from, say, a high potential for technology diffusion (low level of GDP per capita) from a high level of EU support (similarly for EU support and the share of agriculture in total employment). To minimize these problems, we exploit the fact that important changes have been going on over time in some of the dimensions taken into account by the analysis, particularly in the working and coverage of EU regional support. Hence what we do in the regression analysis is to pool the data for the period 1989–97 (after the reform) with the ones for the previous period 1980–88. To allow for changes in the working of the variables between the two periods, we introduce a first-period 'time-slope dummy' (TSD) for each independent variable of the model. However, although we started out with time-slope dummies for all variables, only the ones that contribute to the explanatory power (reduce the residual variance) of the model were retained in the final reporting (using the general to specific method).

As is customary in analyses on pooled cross-country time-series datasets, we report regressions both with and without country-specific constant terms ('country dummies') in the regressions. The interpretations of the tests differ slightly, however, depending on whether these country-specific factors are allowed for or not. The first (including country-specific constant terms) is equivalent to testing the explanatory power of the model for the differences in growth across regions within each country (leaving the cross-country differences to the country-specific terms), while the second (a common constant term) implies a test of the explanatory power of our model on regional growth in Europe as a whole (irrespective of country borders).

IV. Results

The results of the econometric analysis are presented in Table 5. As can be seen from the R^2, the model presented explains regional growth well, but the version that allows for country-specific factors is clearly superior to the one without, and will be preferred in the following. However, most estimates are robust to the inclusion of country dummies. The main exception is the potential for catch-up (initial GDP per capita) which is much lower when country specific factors are included. By inspection of the estimated country dummies, we observe that there are three countries with growth rates that deviate from the average: Portugal and Spain grow significantly faster, and France grows a lot more slowly than the others. This means that when country-specific factors are included, the catch-up of Portuguese and Spanish regions towards the

Table 5: Explaining Regional Growth, European Regions, 1980–97*

	Large Sample without Country Dummies	*Large Sample with Country Dummies*	*Small Sample with Country Dummies*
Constant	0.060		
	(5.79)		
Initial GDP per capita	–0.017	–0.0097	–0.0084
	(4.87)	(2.73)	(1.87)
Initial–TSD	0.0033	0.0044	0.0057
	(3.43)	(5.43)	(6.30)
Agriculture	–0.030	–0.035	–0.023
	(3.65)	(4.05)	(1.45)
Manufacturing	–0.0087	–0.024	–0.027
	(0.95)	(3.03)	(3.30)
Infrastructure	0.0011	0.00044	0.00091
	(2.77)	(1.16)	(2.63)
Infrastructure–TSD	–0.0017	–0.0017	–0.0019
	(3.08)	(3.80)	(5.29)
Unemployment	–0.00059	–0.00074	–0.0011
	(2.91)	(3.36)	(3.51)
Unemployment–TSD	0.00080	0.00072	0.00072
	(3.70)	(3.86)	(2.11)
Population density	0.0015	0.00065	–0.00058
	(1.59)	(0.77)	(0.67)
R&D	0.0010	0.0029	0.0022
	(0.64)	(1.94)	(1.73)
EU support	0.0057	0.0046	0.0068
	(5.36)	(4.87)	(3.24)
EU–TSD	–0.0039	–0.0027	–0.010
	(2.93)	(2.29)	(2.33)
D-Belgium		0.047	0.046
		(4.39)	(3.26)
D-Germany		0.049	0.046
		(4.61)	(3.10)
D-Greece		0.051	
		(4.91)	
D-Spain		0.055	
		(5.06)	
D-France		0.039	0.037
		(3.68)	(2.50)
D-Italy		0.049	0.046
		(4.42)	(2.97)
D-Portugal		0.056	
		(5.69)	
D-UK		0.050	0.048
		(4.87)	(3.47)
Country dummies	No	Yes	Yes
Adjusted R^2	0.483	0.910	0.924
N	190	190	128

Note: *t–statistics in brackets.

European average is explained by these factors, rather than the potential for catch-up.[16]

As previously, we report results (for our preferred model) for two different samples, a large sample, identical to what we previously called 'actual sample', and a somewhat smaller sample excluding the three southern countries that joined the community in the 1980s. Generally, the results are quite robust to changes in the composition of the sample. This increases our confidence in the results. However, although the difference across the two samples is small in qualitative terms, there are some differences in the size and significance of the individual coefficients. This holds, in particular, for infrastructure, unemployment and EU support, all of which had a larger impact in the smaller sample. The latter may indicate that EU support is more efficient in 'advanced' regions. This would not be totally unexpected, since these regions may be assumed to have more developed 'social capabilities' (Abramovitz, 1994).

Concentrating on the larger of the two samples (and the version with country dummies) we see that, in the second period, all variables have the expected signs, and that the estimates in all but two cases ('infrastructure' and 'population density') are significantly different from zero at conventional significance levels. This also includes EU regional support. The first period is a bit messier, however. First, the estimated effect of the scope for diffusion – measured by the initial level of GDP per capita – is appreciably smaller. Second, among the complementary variables, 'unemployment' ceases to have a significant impact (with an estimate close to zero) while 'infrastructure' turns up as significant and wrongly signed. Third, and most interesting from the perspective of this article, the evidence of a positive impact of EU regional support is much weaker in the first period. This pattern is in fact even more pronounced for the smaller sample, for which there appears to be no evidence at all for a positive effect of regional support during the 1980s.

Thus, there appears to be evidence of a change in how European regional support schemes affect regional growth. To get a grasp of the quantitative effect of this, we calculated how our preferred model would explain the difference in growth performance between the three poorest and the three richest regions of our (large) sample. The calculation showed that, in the first period, differences in regional support contributed slightly less than 0.2 per cent to the observed difference in growth. In the second period this contribution had grown to about 1.0 per cent, a sizeable increase.[17] Although some of

[16] Arguably, this does not constitute much of an explanation. And it certainly does not rule out the fact that the potential for catch-up was important for Portuguese and Spanish growth in this period. But it shows that there must be some other unidentified country-specific factors at work. For instance, why (until very recently) was poor Greece not doing better?

[17] Note that this estimate is likely to include the effects of matching funds as well, since these are nearly perfectly correlated with the support from EU sources.

this has to do with the general increase in the amount of regional support, and with the fact that some of the poorest regions in our sample received no support at all in the first half of the 1980s, an important share of this increase no doubt stems from the fact that the estimated coefficient is so much higher in the most recent period.

How sensitive is this result to changes in the set-up of the test? We conducted a whole battery of tests, some of the most interesting of which are reported in Table 6. First we tested for a change in the length of our two time periods by moving the dividing year back or forward.[18] There were some differences in the size and significance of the individual coefficients across the various regressions, but the qualitative result, a significant, positive impact of EU regional support (particularly in the second period), remained the same. Then we tested for the inclusion of a period-specific constant term to take into account the possibility of, say, changes in the macroeconomic climate (or a common shock) from one period to the next (Table 6a). This possibility did not receive much support, however, since the estimated period dummies were not significant at conventional levels in any of the tests. But, for the larger sample, the inclusion of this dummy variable had the effect of reducing the impact of the time-series dummy for EU support, which now lost much of its significance. The impact of EU support also became slightly lower. However, these changes did not carry over into the smaller sample, which yielded estimates more in line with the base regressions (Table 5).

Table 6: Additional Tests*

	(a) Including a Period Dummy		*(b) Demand-adjusted GDP*	
	Large Sample	*Small Sample*	*Large Sample*	*Smaller Sample*
EU support	0.0037	0.0070	0.0038	0.0067
	(2.55)	(3.31)	(4.03)	(3.15)
EU-Tsd	–0.0016	–0.011	–0.0017	–0.0098
	(0.89)	(2.50)	(1.46)	(2.27)
Period dummy	–0.012	0.018		
	(0.73)	(1.017)		
Country dummies	Yes	Yes	Yes	Yes
Adjusted R^2	0.910	0.924	0.908	0.924
N	190	128	190	128

Note: *t–statistics in brackets.

[18] The regressions with a longer second period tended to yield higher estimates for the impact of EU support, while those with a shorter second period returned estimates roughly equal to the base regression reported in Table 5. In both cases there was a marked difference in the efficiency of the support between the two periods (with a significantly lower impact in the first period). However, the explanatory power was higher in the base regression, implying that the division made fits the data rather well.

Next we asked to what extent the reported results are affected by not taking into account the substantial increase in support from 1994 onwards (Figure 1). Although it is unlikely that this increase would lead to substantial supply effects in such a short time-span, it certainly has a demand effect. If the long-run supply effects and the short-run demand effects are correlated, as may be likely, there is a risk that we overestimate the long-run supply effect. To check for this, we did the following experiment. Based on existing macroeconomic evidence[19] we adjust the level of GDP in the regions downwards by subtracting the (estimated) demand effect from European regional support in the final year (1997).[20] The result of the experiment is reported in Table 6b. Again the small sample results are in line with the base regression (Table 5). For the large sample, the numerical values of the estimate for EU support are (as in the previous case) slightly lower than in the base regression (Table 5). Moreover, the estimated value of the time-series dummy for EU support is lower and less significant (though it is still significantly different from zero at the 15 per cent level). Our interpretation of this is that the qualitative findings reported earlier are supported, but it points to a possible difference between the two samples. For the more developed member countries, there is very clear evidence of a change in the efficiency of the support. When the new, poorer member countries that joined during the 1980s are included into the investigation, overall efficiency drops and the evidence of a change in the impact weakens.

Conclusion

In previous work we have demonstrated that the process of regional convergence that characterized most of the Member States of the European Union from the 1950s onwards came to an end around 1980 and that there has, in general, been little change since then. To the extent that there has been any tendency towards convergence, it has been at the country level, related to catch-up by the relatively poor southern countries that joined the EU during the 1980s. Hence, it appears that these countries, particularly Portugal and Spain, have benefited a good deal from their integration into the European

[19] The available evidence comes from the national level, and is based on different methods/models. Our reading of the evidence is that a short-run demand multiplier of unity seems to be an acceptable assumption (Honohan, 1997; Commission, 2001). What we do is to apply this to the regional level. It is possible that this is an overestimation, since import shares are certainly higher at the regional than at the national level.
[20] Ideally we would have done the same for the last year of the preceding period, but since we do not have a complete regional breakdown of the support for that year, this was not possible. However, since support was so much lower in the first period, the possible 'error' of not doing it is likely to be small.

Union.[21] Within countries, however, there has at best been a standstill. This article, presenting new and more recent evidence, confirms these trends.

A particularly challenging question is, to what extent regional support from the European Union, designed to foster growth and convergence and improve social cohesion, has had a real impact on this situation. In previous work we have faced great problems in finding convincing evidence for assuming a positive effect, as intuition indeed would suggest (Fagerberg and Verspagen, 1996; Cappelen *et al.,* 1999). In recent years – following the reforms – this support has increased in importance, and it is thus natural to ask what are the consequences of such support. The evidence presented in this article suggests that EU regional support through the structural funds has a significant and positive impact on the growth performance on European regions and, hence, contributes to greater equality in productivity and income in Europe.[22] These findings, although based on different data and methods, support the conclusions reached in Commission (2001). Moreover, there is evidence, particularly for the more developed parts of the EU, of a change in the impact of the support in the 1990s, indicating that the 1988 reform may have succeeded in making EU regional policy more effective. This may certainly be seen as comforting news for European policy-makers.

However, it needs to be emphasized that there are also other factors that have to be taken into account. First, there is clear evidence suggesting that the economic effects of regional support are much stronger in more developed environments. This suggests that the impact of such support is crucially dependent on the receptiveness of the receiving environment. Hence, it seems that support is least efficient where it is most needed. This throws some doubt on the validity of optimistic estimates, reached with the help of general macroeconomic simulation models, of the impact of support in poorer member countries in the south (Commission, 2001). Moreover, the estimates obtained for the empirical growth model used in this article suggest that growth in poorer regions is greatly hampered by an unfavourable industrial structure (dominated by agriculture) and lack of R&D capabilities. Thus, an important

[21] This may be interpreted as good news for the eastern European countries that are in the process of becoming members. Note, however, that the performance of Greece until very recently has been much less impressive.

[22] Another recent study, based on a sample of 185 NUTS II regions between 1980 and 1996, concludes otherwise: 'The substantial public resources funnelled by the community to less developed regions do not enhance the capacity of these regions … . Instead, they simply redistribute income' (Boldrin and Canova, 2001, p. 211). This conclusion is based on the finding, reported by several studies (see Section I), of little (if any) recent convergence in income per capita across European regions. However, since this outcome may be affected by a host of other factors (in addition to regional support), it cannot be taken as direct evidence of policy ineffectiveness. To assess the impact of regional support on growth, one needs to control for other growth-enhancing (or retarding) factors. Moreover, the study fails to take into account the possibility of a shift in policy effectiveness during the period, related to the substantial overhaul of the system for regional support in 1988.

policy conclusion of the present exercise is that to get the most out of the support, this needs to be accompanied by policies that improve the competence of the receiving environments, for instance by facilitating structural change and increasing R&D capabilities in poorer regions.[23] Such policies must necessarily be of a long-term nature.

Appendix: Regions in the Sample[a]

NUTS code	*Name*	*NUTS code*	*Name*
be1	Brussel	es11	Galicia
be2	Vlaanderen	es12	Principado de Asturias
be3	Wallonie	es13	Cantabria
de1	Baden-Wurttemberg	es21	Pais Vasco
de2	Bayern	es22	Comunidad Foral de Navarra
de5	Bremen	es23	La Rioja
de6	Hamburg	es24*	Aragon
de7	Hessen	es3	Comunidad de Madrid
de9	Niedersachsen	es41	Castilla y Leon
dea	Nordrhein-Westfalen	es42	Castilla-la Mancha
deb	Rheinland-Pfalz	es43	Extremadura
dec	Saarland	es51	Cataluna
def	Schleswig-Holstein	es52	Comunidad Valenciana
gr11	Anatoliki Makedonia, Thraki	es53	Islas Balearas
gr12*	Kentriki Makedonia	es61	Andalucia
gr13	Dytiki Makedonia	es62	Region de Murcia
gr14	Thessalia	es63	Ceuta y Melilla
gr21	Ipeiros	es7	Canarias
gr22	Ionia Nisia	fr1	Île de France
gr23	Dytiki Ellada	fr21	Champagne-Ardenne
gr24*	Sterea Ellada	fr22	Picardie
gr25	Peloponnisos	fr23	Haute-Normandie
gr3*	Attiki	fr24	Centre
gr41	Voreio Aigaio	fr25	Basse-Normandie
gr42*	Notio Aigaio	fr26	Bourgogne
gr43	Kriti	fr3	Nord-Pas-de-Calais

[23] Interestingly, a recent empirical study of the effects of EU regional support on the pattern of specialization of member countries (Midelfart-Knarvik and Overman, 2002), suggests that such support has made the recipient countries and regions better equipped to attract and absorb R&D-intensive industry. Although the authors of that study express some reservation against their findings, because it works against the so-called 'principle of comparative advantage' (according to which less-developed regions should specialize in low-skill activities), from our perspective it would be interpreted as an indication of policy effectiveness.

fr41	Lorraine	it72	Molise
fr42	Alsace	it8	Campania
fr43	Franche-Comte	it91	Puglia
fr51	Pays de la Loire	it92	Basilicata
fr52	Bretagne	it93	Calabria
fr53	Poitou-Charentas	Ita	Sicilia
fr61	Aquitane	Itb	Sardegna
fr62	Midi-Pyrenees	nl1*	Noord-Nederland
fr63	Limousin	nl2*	Oost-Nederland
fr71	Rhône-Alpes	nl3*	West-Nederland
fr72	Auvergne	nl4*	Zuid-Nederland
fr81	Languedoc-Roussillon	pt11	Norte (P)
fr82*	Provence-Alpes-Côte d'Azur	pt12	Centro (P)
it11	Piemonte	pt13	Lisboa e Vale do Tejo
it12	Valle d'Aosta	pt14	Alentejo
it13	Liguria	pt15	Algarve
it2	Lombardia	uk1	North (UK)
it31	Trentino-Alto Adige	uk2	Yorkshire and Humbershire
it32	Veneto	uk3	East Midlands
it33	Friuli-Venezia Giulia	uk4	East Anglia
it4	Emilia-Romagna	uk5	South East (UK)
it51	Toscana	uk6	South West (UK)
it52	Umbria	uk7	West Midlands
it53	Marche	uk8	North West (UK)
it6	Lazio	uk9	Wales
it71	Abruzzi	Uka	Scotland
		Ukb	Northern Ireland

Note: [a] 10 of these, marked with *, are not included in the actual sample (used in the regression analysis) due to the lack of data for certain variables and years.

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