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Working Paper 02.14

Department of Technology Management

Technische Universiteit Eindhoven, The Netherlands

September 2002

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Abstract

The tendency towards regional convergence that characterised most of the member states of the European Union from the 1950s onwards came to an end around 1980. To the extent that there has been any tendency towards convergence since then, it has been at the country level, related to the catch up by the relatively poor Southern countries that joined the EU during the 1980s. Within countries, however, there has at best been a standstill. A particularly challenging question is to what extent regional support from the EU , designed to foster growth and convergence and improve social cohesion, has had a real impact on this situation. A major reform of the EU Structural Funds was decided in 1988. Between 1989 and 1993 the financial resources allocated to these funds more than doubled in real terms, and this increase continued in the following period (1994-1999). The evidence presented in this paper 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. Moreover, there is evidence of a trend break in the impact of the support in the 1990s, indicating that the 1988 reform may have succeeded in improving EU regional policy so that it becomes more effective. However it needs to be emphasised that there also are diverging factors at play. First there is very clear evidence suggesting that the economic effects of regional support are much stronger in more developed environments. Thus what comes out of such support is crucially dependent of how competent the receiving environment is. Second, the results suggest that growth in poorer regions is greatly hampered by an unfavourable industrial structure (dominated by agriculture) and lack of R&D capabilities. Thus, to get the maximum 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 increase R&D capabilities in poorer regions. Such policies must necessarily be of a long-term nature.

1. Introduction[1]

Greater equality across Europe in productivity and income has been one of the central goals for the European Community since the early days of European economic integration and various policy measures have been introduced to help achieve this goal (the so-called "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 tendency towards convergence came to a halt in the beginning of the 1980s (Neven and Goyette 1995, Fagerberg and Verspagen 1996). In the decade that followed very little regional convergence occurred within individual EU member states (Cappelen, Fagerberg and Verspagen 1999, European Commission 2001). To the extent that there has been any convergence, it appears to have been mainly at the country level (catch up by the new Southern member countries). These findings beg new questions about the effectiveness of existing policies.

As described in section three of this paper the EU Structural Funds were reformed 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.[2] Between 1989 and 1993 the financial resources allocated to these funds more than doubled in real terms. A similar increase took place in the 1994-1999 period. Several new policy instruments aimed at increasing "social cohesion" were also introduced, chief among them the so-called "Cohesion fund". The reorientation of European regional policy, the increase of the budget and the recent slowdown of convergence all underline the need for a thorough assessment of the outcomes of these policies. The current discussion of a possible enlargement of the European Union, and the possible role that regional policy may play in an enlarged union, further underlines the need for an improved understanding of how these policies work and what the long-run effects are.

So far, such assessment has mainly been descriptive (e.g., European Commission 1997, Bachtler and Turok 1997, Heinelt 1996, Staeck 1996), or based on simulations of large macroeconomic models (European Commission 1999, 2001). The first approach consists mainly 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 help us to distinguish between successful or 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 paper we will try to estimate the long-run effects of European regional support through the structural funds in a more direct manner. We have in previous work showed 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, Verspagen and Caniëls 1997, Cappelen, Fagerberg and Verspagen 1999). What we will do in this paper is to include regional support through the structural funds into 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 paper is as follows. In section two we present new evidence on growth and convergence in the European Union the 1980s and 1990s. The analysis confirms that there is more convergence at the national (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/mid 1980s, than for the narrower group of countries that had joined earlier. In section three we start to analyse EU regional support. We show that such support 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. For instance, as pointed out in section four below, 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 four outlines the empirical model to be used in the analysis and its theoretical underpinnings, considers how it may best be applied to the existing data and presents the results. The final sections concludes and discusses the implications for policy.

2. Regional convergence?

It is by now well established that the distribution of regional incomes per capita in Europe became more equal after World War II (Molle 1980, Molle and Cappellin 1988). However, this convergence in regional incomes seems to have slowed down or come to halt after 1980 (Fagerberg and Verspagen 1996, Cappelen, Fagerberg and Verspagen 1999). This is in particular the case for the countries that were members already in the 1970s. But during the 1980s three relatively poor southern European countries joined the Union and as might be expected, this has 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 teh previous Western Germany). Incomes are made comparable by using current purchasing power parities (based on ESA95[3]). Table 1 presents an overview of 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[4], and the regional standard deviation within countries[5] (i.e., adjusted for cross-country differences in GDP per capita). The former is a measure of the degree of regional dispersion in the EU as a whole (irrespective of which country the region belongs to), the latter indicates to what the extent the change in the former reflects changes in dispersion between regions within individual member countries (the measures are normalised so that the numbers are comparable across years). We present these indices for three different samples, the total sample, the sample used in the econometric analyses presented later in this paper (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 includes in our

investigation[6], the actual sample is slightly smaller due to lack of data for certain regions for some variables included in the econometric analysis presented in section 4.

Table 1. Dispersion of regional GDP per capita in Europe, 1980-1997.

	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).

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 it 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, what these numbers show is 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.

3. Regional support in the European Union

Regional support is one of the key policy areas in the European Union. The idea driving this set of policies is the notion of social and economic 'cohesion', i.e., the desire to reduce differences in welfare between regions in the Union. The first official regional policy initiative was the creation of the European Regional Development Fund (ERDF) in 1975.[7] Later on the European Social Fund (ESF, mostly concerned with employment), the European Agricultural Guidance and Guarantee Fund (EAGGF, aimed at developing agriculture), as well as several smaller measures were added (we will refer to the complete group of funds as

'regional funds' or 'structural funds'). Allocation of funds was initially done by fixed national quota.

The structural funds went through several reforms (1979, 1984), until in 1988 a completely new system was devised. In the new system, several 'objectives' were formulated, at which the regional funds were to be aimed. For the purposes of this paper, three of these objectives are of crucial importance. These are:

- Objective 1, aimed at regions lagging behind in terms of GDP per capita, defined as regions with GDP per capita lower than 75% 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, 4 aimed at unemployment; and 5a aimed at common agricultural policy) cannot easily be attributed to individual regions, and hence we will not take these into account in the analysis. In addition to the re-orientation of the funds according to these objectives, the 1988 reform increased the budget for regional policy at the European level significantly (table 2). A similar increase occurred in the latter half of the 1990s. Several new policy instruments aimed at increasing "social cohesion" were also introduced, chief among them the so-called "Cohesion fund", directed towards the new and poorer member countries in the South.[8]

Table 2 gives an indication of the magnitude of regional support before and after the reforms of the funds. During the period 1980-1984, which we take as a reference for the period before the reforms, the average region in our sample received European regional support equal to around 0.25% of its GDP. Note, however, that this value is influenced by the fact that Spain and Portugal were not members of the European Community at the time, and hence did not receive any support. Without these two countries, the mean value is 0.36% of GDP. During the period 1989 - 1993 the mean increases to 0.84%, i.e., more than twice the level ten years earlier. In the following five year period (1994-1999) the level of support, especially for objective 1 regions, continued to increase so that the total level of support in percentage of GDP approached 2,0 % on average. If we include the Cohesion Fund, which came into operation in 1993, this number increases even further, to 2.4%.[9]

Table 2. Regional support in per cent of GDP, average over regions in our sample

	1980-84	1989-1993		1994-1999	
		ex. CF	in. CF	ex. CF	in. CF
Belgium	0.016	0.028	0.028	0.117	0.117
Germany	0.024	0.020	0.020	0.061	0.061
Greece	1.571	2.367	2.455	6.935	8.407
Spain	0.000	0.685	0.727	1.620	2.087
France	0.068	0.083	0.083	0.149	0.149
Italy	0.293	0.484	0.484	0.743	0.743
Portugal	0.000	2.863	2.962	5.934	7.110
UK	0.162	0.157	0.157	0.169	0.169
Mean	0.267	0.836	0.864	1.966	2.355

Source/note: Calculations on data taken from EUROSTAT regional yearbooks and European Commission (1997, 2000), "ex/in CF" means "excluding/including Cohesion Fund". All data in current PPS (ESA95).

As is evident from the table the countries that receive the largest amount of support (relative to GDP) are Portugal and Greece. Spain follows at some distance with Italy is in fourth place. Although the overall level of support increases sharply, the relative distribution of funds over countries does not change very much over the 1990s. For the period following the reforms there also exist data on national public and private matching funds. 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 paper 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 the recent EU regional policy, as one of the main purposes of the 1988 reform was to strengthen the coordination between the regional policy of the Member States and the EU structural funds on long term plans and objectives[10].

4. Economic growth, innovation-diffusion and EU regional support: econometric evidence for European regions, 1980-1997

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 neo-classical theory of economic growth

(Solow 1956), is based 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 on technology, emphasising its public as well as private character, and the complementarity with other factors that take part in 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 public good model do not fit regional growth very well (see, for instance, Sala-i-Martin 1996). Moreover, the assumption of technology as a (global) public good does not carry much empirical support. On the contrary, decades of empirical research on the creation and diffusion of technology within and across country boarders 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 do - 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.

We have in previous work analyzed 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 knowledge 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, 2002a). Thus, real world catch-up is far from the easy, mechanical process envisaged by the traditional neoclassical 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):

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

By differentiating and dividing through with Q, letting small-case letters denote growth rates:

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

Assume further, as customary 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:

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

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

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

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.

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'.[13] For innovation we use R&D intensity, defined as business enterprise R&D personnel as a percentage of total employment. We expect a positive impact of this variable. For diffusion potential we use, as 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 include:

- 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 matters. 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 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, Caniëls and Verspagen, 1997). Long-term unemployment also leads to deprecation 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 materialise. 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, the way in which this support are allocated to regions poses a problem for the estimationl. As pointed out in the previous section 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.

In order to chart the extent of this problem, we performed a cluster analysis with the explanatory variables of our model as the inputs. European regional support was broken down by objective (1, 2, 5b) in this analysis. We arbitrarily fix the number of clusters to five, and apply a so-called K-means clustering algorithm. All variables were standardised before entering in the clustering algorithm. We obtained one cluster of two regions, and four larger clusters. The cluster of two regions consists of highly urbanised small regions (Brussels in Belgium and Cueta y Mililla in Spain) and will be disregarded in the following. The characteristics of the four larger clusters are documented in Table 3. Note that because the data were standardised, a value of zero corresponds to the sample mean, and plus (minus) one corresponds to one standard deviation above (below) the mean.

Table 3. A Cluster Analysis of European regions 1989-1993

Variable	Clusters			
	1 - 'little support'	2 - 'Objective 1'	3 - 'Objective 2 & 5b'	4 – 'Intermediate'
Num. of regions	19	34	10	40
Agriculture	-0.74	1.05	-0.47	-0.38
Manufacturing	0.51	-0.61	0.99	0.14
Unemploy-ment.	-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 Cap. 1988	1.10	-1.03	-0.09	0.33
R&D	1.42	-0.82	-0.25	0.08

Cluster 1 is a cluster 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 much 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) have both 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 could be expected by the nature of Objective 2 support, these regions score high on manufacturing. The final cluster (4), labelled "intermediate", is a group of peripheral regions, characterized by relatively bad 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 1989 reform are indeed aimed at different groups of regions. One can indeed speak of a 'typical Objective 1 region', and the same holds to some extent for the two other objectives. 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).

Table 4: Correlation coefficients between selected explanatory variables in our model for the period 1989-1997

	European support (percentage 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

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 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 or EU support (similarly for EU support and the share of agriculture in total employment). To minimize these problems we exploit the fact that there have been important changes going on over time in some of the dimensions taken into account by the analysis, particularly in the working and coverage of the EU regional support. Hence what we do in the regression analysis is to pool the data for the period 1989-1997 (after the reform) with the ones for the previous period 1980-1989. 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 interpretation 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 model of our model on regional growth in Europe as a whole (irrespective of country-borders).

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 that grow significantly faster, and France that grows a lot slower, than the others. This means that when country-specific factors are included, the catch-up of Portuguese and Spanish regions towards the European average is explained by these factors, rather than the potential for catch-up.

We also report estimates of 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. The difference across the two samples is small in qualitative terms, but there are some differences in the size and significance of the individual coefficients. This holds, in particular, for Infrastructure, Unemployment and EU-support, which all 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).

Table 5. Explaining regional growth, European regions, 1980-1997*.

	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 (4,87)	-0,0097 (2,73)	-0,0084 (1,87)
Initial-Tsd	0,0033 (3,43)	0,0044 (5,43)	0,0057 (6,30)
Agriculture	-0,030 (3,65)	-0,035 (4,05)	-0,023 (1,45)
Manufacturing	-0,0087 (0,95)	-0,024 (3,03)	-0,027 (3,30)
Infrastructure	0,0011 (2,77)	0,00044 (1,16)	0,00091 (2,63)
Infrastructure-Tsd	-0,0017 (3,08)	-0,0017 (3,80)	-0,0019 (5,29)
Unemployment	-0,00059 (2,91)	-0,00074 (3,36)	-0,0011 (3,51)
Unemployment-Tsd	0,00080 (3,70)	0,00072 (3,86)	0,00072 (2,11)
Population density	0,0015 (1,59)	0,00065 (0,77)	-0,00058 (0,67)
R&D	0,0010 (0,64)	0,0029 (1,94)	0,0022 (1,73)
EU support	0,0057 (5,36)	0,0046 (4,87)	0,0068 (3,24)
EU-Tsd	-0,0039 (2,93)	-0,0027 (2,29)	-0,010 (2,33)
D-Belgium		0,047 (4,39)	0,046 (3,26)
D-Germany		0,049 (4,61)	0,046 (3,10)
D-Greece		0,051 (4,91)	
D-Spain		0,055 (5,06)	
D-France		0,039 (3,68)	0,037 (2,50)
D-Italy		0,049 (4,42)	0,046 (2,97)
D-Portugal		0,056 (5,69)	
D-UK		0,050 (4,87)	0,048 (3,47)
Country-dummies	**No**	**Yes**	**Yes**
Adjusted R^2	0,483	0,910	0,924
N	190	190	128

**t-statistics in brackets*

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 paper, 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 does not appear to be any evidence at all for a positive effect of regional support during the 1980s.

Thus there appears to be clear evidence of a trend break 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 % to the observed difference in growth. In the second period this contribution had grown to about 1.0 %, a sizeable increase.[16] Although some of 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 did not receive any 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 of which some of the most interesting 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 (not reported[17]). 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 macro-economic climate from one period to the next (Table 6, a). This possibility did not receive much support, though, since the estimated period-

dummies were not significant at conventional levels in any of the tests. But for the larger sample the inclusion of such a dummy did compete with time-series dummy for EU support, which now lost much its significance. The impact of EU support also became slightly lower. However, these changes did not carry over the smaller sample, which yielded estimates more in line with the base regressions (Table 5).

Next we asked to what extent the reported results are affected by not taking into account the support through the Cohesion Fund, which came into effect in 1993. This is a tricky question, because although the Cohesion Fund has a clear spatial dimension, a regional breakdown of the support is not available. What we did, as an experiment, was to assume that it was allocated to regions in the same way as the regional support through the structural funds. However, including the support through the Cohesion Fund in this way did not affect the estimates at all (Table 6, b). This is not necessarily so surprising, given that the total support through the Cohesion Fund before 1994 was small. But in the longer run this type of support becomes quite substantial. Moreover, as previously noted, there is a substantial increase in other types of support as well from 1994 onwards (Table 2). 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 is likely, there is risk that we overestimate the long run supply effect.

To check for this we do the following experiment. Based on existing macro-economic evidence[18] we adjust the level of GDP in the regions downwards by subtracting the (estimated) demand-effect from European regional support (including the Cohesion Fund) in the final year (1997)[19]. The result of the experiment is reported in Table 6, c. The estimated effects of regional support are still positive and significant, and – as earlier – higher in the small than in the large sample. But the numerical values of the estimates are a bit lower than in the base regression (Table 5). The time series dummies for regional support are still negative, as in the other cases, although for the large sample the estimate of the dummy ceases to be significant as conventionally defined. Our interpretation of these additional tests is that the qualitative findings reported earlier are supported. But it is possible that the estimated effects of regional support for the period following the reforms reported in table 5 are a bit on the high side due to the difficulty of distinguishing between short-run demand-effects and long-run supply-effects.

Table 6: Additional tests*

	a) Including a period dummy		b) Including Cohesion fund		c) Demand- adjusted GDP	
	Large sample with country dummies	Smaller sample with country dummies	Large sample with country dummies	Smaller sample with country dummies	Large sample with country dummies	Smaller sample with country dummies
EU support	0,0037 (2,55)	0,0070 (3,31)	0,0045 (4,87)	0,0068 (3,24)	0,0032 (3,49)	0,0056 (2,64)
EU-Tsd	-0,0016 (0,89)	-0,011 (2,50)	-0,0025 (2,20)	-0,010 (2,32)	-0,0013 (1,10)	-0,0087 (2,03)
Period dummy	-0,012 (0,73)	0,018 (1,017)				
Country dummies	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0,910	0,924	0,910	0,924	0,907	0,923
N	190	128	190	128	190	128

**t-statistics in brackets*

5. Conclusion

We have in previous work 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 the 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 Union.[20] Within countries, however, there has at best been a standstill. This paper, presenting new and more recent evidence, confirms these trends.

A particularly challenging question is to what extent regional support from the EU , 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, Fagerberg and Verspagen 1999). In recent years – following the reforms - this support has increased in importance and it is thus natural to ask what the consequences of such support are. The evidence presented in this paper 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. Moreover, there is evidence, particularly for the more developed parts of the EU, of a trend break in the impact of the support in the 1990s, indicating that the 1988 reform may have succeeded in improving EU regional policy so that it becomes more effective.

However it needs to be emphasized that there also are diverging factors at play. First there is clear evidence suggesting that the economic effects of regional support are much stronger in more developed environments. Thus what comes out of such support is crucially dependent of how competent the receiving environment is. Moreover, the estimates obtained for the empirical growth model used in this paper suggest that growth in poorer regions is greatly hampered by an unfavourable industrial structure (dominated by agriculture) and lack of R&D capabilities. Thus, to get the maximum 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 increase R&D capabilities in poorer regions. Such policies must necessarily be of a long-term nature.

References

Abramovitz, M. (1994), 'The Origins of the Postwar Catch-Up and Convergence Boom', in J. Fagerberg, B. Verspagen and N. von Tunzelmann (eds), *The Dynamics of Technology, Trade and Growth*, Aldershot, UK: Edward Elgar, pp. 21–52.

Armstrong, H., J. Taylor and A. Williams (1994), 'Regional policy' , in M. J. Artis and N. Lee (eds), *The Economics of the European Union, Policy and Analysis*, Oxford University Press, pp. 172-201

Bachtler, J., and I. Turok, eds. 1997. *The Coherence of EU Regional Policy. Contrasting Perspectives on the Structural Funds*. London: Jessica Kingsley Publishers, Regional Studies Association

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

Begg, I. and D. Mayes (1993), 'Cohesion in the European Community. A Key Imperative for the 1990s?', *Regional Science and Urban Economics*, 23, 427–48.

Begg, I. (1997) 'Reform of the Structural Funds after 1999', *European Planning Review*, 5, 675–89.

Cappelen, A., J. Fagerberg and B. Verspagen (1999), 'Lack of Regional Convergence', in J. Fagerberg, P. Guerrieri and B. Verspagen (eds), *The Economic Challenge for Europe. Adapting to Innovation Based Growth*, Edward Elgar, chapter 6.

Corvers, F. (1995), *Regional Policy within the European Union: The regional implications of a changing paradigm*. Coventry, Paper for the ESRC seminar on Regional and Local Responses to European Integration, 12 October, University of Warwick

Dosi, G. (1988) Sources, Procedures and Microeconomic Effects of Innovation, *Journal of Economic Literature* 26: 1120-71

Dosi, G., K. Pavitt, and L.G. Soete (1990) *The Economics of Technical Change and International Trade,* London: Harvester Wheatsheaf

European Commission. (1997), *The impact of structural policies on economic and social cohesion in the Union*, 1989-99. Luxembourg, Office for Official Publications of the European Communities.

European Commission (1999), *Sixth Periodic Report on the social and economic situation and development of the regions of the European Union*, consulted from the www: http://europa.eu.int/comm/regional_policy/document/radi/radi_en.htm

European Commission (2000), *11th Annual Report on the Structural Funds (1999)*, Volume II, Brussels,

European Commission (2001), *The Second Report on Economic and Social Cohesion*, Brussels.

Fagerberg, J. (1987), 'A Technology Gap Approach to Why Growth Rates Differ', *Research Policy*, 16, 87–99.

Fagerberg, J. (1988), 'Why Growth Rates Differ', in Giovanni Dosi et al. (eds), *Technical Change and Economic Theory*, London: Pinter Pubs, pp. 432–57.

Fagerberg, J. (1994), 'Technology and International Differences in Growth Rates', *Journal of Economic Literature*, 32, 1147–75

Fagerberg,J. (2002), *Technology, Growth and Competitiveness: Selected Essays*, Cheltenham: Edward Elgar

Fagerberg,J. (2002a) "Economic Growth and Convergence", in W. Lazonick (ed.), *The IEBM Handbook of Economics*, London: Thomson, pp. 413-420

Fagerberg, J. and B. Verspagen (1996), 'Heading for Divergence? Regional Growth in Europe Reconsidered', *Journal of Common Market Studies*, 34, 431–48.

Fagerberg, J., B. Verspagen and M. Caniëls (1997), 'Technology, Growth and Unemployment across European Regions', *Regional Studies*, 31, 457–66.

Grossman, G.M. and E. Helpman (1991) *Innovation and Growth in the Global Economy*, Cambridge (USA): The MIT Press

Heinelt, H., and R. Smith, eds. 1996. *Policy Networks and European Structural Funds*. Aldershot: Avebury

Honohan, P.(eds.) (1997), EU Structural Funds in Ireland, A Mid-Term Evaluation of the CSF 1994-99, The Economic and Social Research Institute, Dublin, 1997

Kaldor, N. (1967), *Strategic Factors in Economic Development*, Cornell University: Itacha.

Molle, W. (1980), *Regional Disparity and Economic Development in the European Community*, Westmead: Saxon House.

Molle, W. and R. Cappellin (eds) (1988), *Regional Impacts of Community Policies in Europe*, Aldershot, UK

Nelson, R.R. and E. Phelps (1966) Investment in Humans, Technological Diffusion and Economic Growth, *American Economic Review* 56: 69-75

Neven, D. and C. Goyette (1995), 'Regional Convergence in the European Community', *Journal of Common Market Studies*, 33, 47–65

Posner, M. V. (1961) International Trade and Technical Change, *Oxford Economic Papers* 13: 323-341

Romer, P. (1990), 'Endogenous technological change', *Journal of Political Economy*, Vol. 98, pp. S71-S102.

Sala-I-Martin, X. (1996), 'Regional cohesion: evidence and theories of regional growth and convergence', *European Economic Review*, Vol. 40, pp. 1325-1352.

Solow, R.M. (1956), 'A contribution to the theory of economic growth', *Quarterly Journal of Economics*, Vol. 70, pp. 65-94

Staeck, N. 1996. The European structural funds. Their history and impact. In *Policy Networks and European Structural Funds*, edited by H. Heinelt and R. Smith. Aldershot: Avebury

Vernon, R. (1966) International Investment and International Trade in the Product Cycle, *Quarterly Journal of Economics* 80: 190-207.

Verspagen, B. (1991), 'A New Empirical Approach to Catching Up or Falling Behind', *Structural Change and Economic Dynamics*, 2, 359–80.

Appendix: Regions in the large sample used in the regression analysis (95+95 observations in the pooled sample)

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

fr3	Nord-Pas-de-Calais
fr41	Lorraine
fr42	Alsace
fr43	Franche-Comte
fr51	Pays de las Loire
fr52	Bretagne
fr53	Poitou-Charentas
fr61	Aquitane
fr62	Midi-Pyrenees
fr63	Limousin
fr71	Rhone-Alpes
fr72	Auvergne
fr81	Languedoc-Roussillon
it11	Piemonte
it12	Valle d'Aosta
it13	Liguria
it2	Lombardia
it31	Trentino-Alto Adige
it32	Veneto
it33	Friuli-Venezia Giulia
it4	Emilia-Romagna
it51	Toscana
it52	Umbria
it53	Marche
it6	Lazio
it71	Abruzzi
it72	Molise
it8	Campania
it91	Puglia
it92	Basilicata
it93	Calabria
ita	Sicilia
itb	Sardegna
pt11	Norte (P)
pt12	Centro (P)
pt13	Lisboa e Vale do Tejo
pt14	Alentejo
pt15	Algarve
uk1	North (UK)
uk2	Yorkshire and Humbershire
uk3	East Midlands
uk4	East Anglia
uk5	South East (UK)
uk6	South West (UK)
uk7	West Midlands
uk8	North West (UK)
uk9	Wales
uka	Scotland
ukb	Northern Ireland

Endnotes

[1] This paper is produced as a part of the "Globalization program" at the Centre for Technology, Innovation and Culture, University of Oslo. A preliminary version was presented at the EMAEE 2001, The 2. European Meeting on Applied Evolutionary Economics, Vienna University of Economics and Business Administration, Vienna, Austria, September 13 - 15, 2001. Helpful discussions with Fabienne Corvers are acknowledged.
[2] For an analysis of regional policy in the EU, including its rationale and the need for reform, see Begg and Mayes (1993) and Begg (1997).
[3] European System of Accounts, ESA 1995, Eurostat/EU-commision, 1996. Hence these data are not directly comparable to the data we have used in previous papers.
[4] 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).
[5] 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).
[6] All members except three small countries for which there was no regional breakdown; Denmark, Ireland and Luxembourg.
[7] The historical description of European regional policy provided in this section is largely based on Corvers (1995).
[8] It might be noted that a further spatial objective (6) was added following the 1995 accession of Austria, Finland and Sweden. However, since we do not include these countries in our investigation we will not discuss this policy measure further here.
[9] The Cohesion Fund has a clear spatial objective but a regional breakdown is not available. We include it here for illustrative purposes only.
[10] For a descriptive analysis of the 1989 reform, see for example Armstrong, Taylor and Williams (1994).
[11] Although Schumpeter did not extend his analysis of innovation-diffusion to the international economy, this seems to be a quite 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, Pavitt and Soete (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).
[12] The presentation of the model draws on Fagerberg (1988).
[13] All data for the variables described below are taken from the EUROSTAT 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.
[15] In both periods we use data for regional support from the first half of the period, 80-84 and 89-93, as independent variables.
[16] 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.
[17] These regressions are available on request. The ones 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.
[18] The available evidence comes from the national level, and is based in different methods/models. Our reading of the evidence is that a short run demand multiplicator of unity seems to be an acceptable

assumption (Honohan 1997, European Commission 2001). What we do is to apply this to the regional level. It is possible that this is an overestimation, since import-shares certainly are higher at the regional than at the national level.

[19] Ideally we would have done the same for the last year of the preceding period but since we do not have a regional breakdown of the support for that year, this was not possible.

[20] 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 has been much less spectacular.

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