How different are the production functions of the European manufacturing sectors? New empirical evidence

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1. INTRODUCTION

During the course of recent years we have witnessed a renewal of interest in cross-country comparisons of productivity and its explanatory factors, this being the case in both the academic and the political sphere.

Among the reasons that have motivated this line of work, emphasis needs to be placed on the desire to improve our knowledge of the restructuring of the industrialised economies, a process that took place during the crisis of the 1970s and the recession of the early 1980s. This was a time when there was a fall in the demand for labour on the part of the manufacturing sector, when it came to represent around a quarter of total employment in the majority of industrialised countries. At the same time, a number of important changes took place in the distribution of labour in this sector, which led, at least in part, to changes in weight from the traditional industries towards more innovative ones.

The aim of this paper is to present empirical evidence on the estimation of industry production functions in the manufacturing sectors of the European Union, accepting that national technologies can be different and that economies of scale can be present.

When considering that the total factor productivity (TFP) in a given sector is equal for all countries and that there are constant returns to scale, the postulate is that the sectoral product of the countries differs only with respect to the different factor endowments. This is very important, given that the Neo-classical model of international trade makes such assumptions in order to forecast a country's pattern of trade and to derive the equalisation of factor prices of those countries that trade among themselves.

Such equalisation implies an identical technological matrix between countries and that for each sector the capital per worker, the output per worker and the profits per worker will be equal between countries. The accumulation of physical capital will increase the aggregate output and the output per worker, but will only increase the income of the owners of the new capital; the capital/labour ratio and the labour productivity in each sector will not change and neither will the remuneration of the labour factor for each level of qualification or the average wage. However, there will be a change in the distribution of the output between sectors due to a reorientation towards those sectors that are more intensive in physical capital.

In response to these formulations, an increasing number of studies have made clear that the different levels of sectoral production across countries cannot be explained exclusively by reference to differences in factor endowments; rather, consideration must be given to economies of scale in national industries and to technological differences across countries[1].

Furthermore, these two assumptions can prevent factor prices from being equal, although international trade tends to equal goods prices. If we suppose a general equilibrium framework, the conditions of full employment and of null profits may be expressed as:

$$A^h x^h = v^h$$

[1] See Dollar, Baumol and Wolff (1988), Trefler (1993, 1995), Dollar and Wolff (1993), Harrigan (1999) and Scarpetta *et al.* (2000).

$$A^{h'}w^h = p$$

where A is the technological matrix $m \times n$ with m factors and n goods, x is the $n \times 1$ vector of outputs, v is the $m \times 1$ vector of factor endowments, w is the $m \times 1$ vector of factor prices and p is the $n \times 1$ vector of goods prices. The super-index h indicates that the technology, the technique, the supply of factors and of goods and the factor prices can be different in each country, whilst the goods prices will equal between countries.

The elements of the matrix A, given that they depend on the factor prices and on the scale of production, can be different in each country, either because there is access to different technologies or because the technique employed differs by virtue of economies (or diseconomies) of scale. Factor prices in each country will be obtained from the joint resolution of the two above expressions and, therefore, they will be a function of factor endowment of each country and of the commodity prices.

Following Harrigan (1999), in this paper we set out to estimate sectoral production functions, allowing for the existence of different technologies between countries and not imposing constant returns to scale.

In order to test the model, we have gathered information on all the manufacturing industry of eight EU countries for the period 1978-1992, sub-dividing the sample into eight productive sectors. Faced with the choice of using either production or value added as the measurement of output, we have opted for the latter, given the lack of appropriate data on intermediate costs and their deflators.

The most important contributions of our study are that it extends earlier contributions in two directions. First, it tests the above hypotheses using all the manufacturing sectors, as compared to only the machinery and mechanical equipment sectors. The second main contribution is that it analyses a more extensive time period than that considered in Harrigan (1999) and for a sample of exclusively European countries (Germany, France, Italy, Sweden, the United Kingdom, Spain, Finland and Denmark) that is more homogenous in economic, technological and institutional terms[2]. These are the only European countries for which we have been able to form a balanced panel with the manufacturing variables we employ for the period in question. Furthermore, we have also carried out a cyclical adjustment by way of the Hodrick-Prescott filter.

The rest of the paper is organised as follows. Section 2 is devoted to the empirical model. The data are described in Section 3 and the results considered in Section 4. Section 5 closes the paper with a review of the main conclusions.

2. EMPIRICAL MODEL

The general Neo-classical production function assumes:

$$y_t = a_t F(k_t, l_t) \qquad (1)$$

where y_t is the aggregate output, k_t and l_t represent the contributions of capital and labour inputs and a_t is the level of technology or *total factor productivity*[3]. Therefore, an aggregate production function is the maximum output that can be produced given the

[2] Harrigan (1999) does not include France, Denmark or Spain. His results are obtained with information for Germany, Italy, the United Kingdom, Finland, the Netherlands (a country for which we do not have the necessary data), Norway (which does not belong to the UE), as well as for four non-European countries, namely Australia, Canada, Japan and the USA.

[3] Among the numerous empirical resarch papers that use the aggregate production function, we can mention Bairam (1996), Tzanidakis and Kirizidis (1996), Casler (1997), Kaskaleris (1997), Felipe (1998), Segoura (1998), Duffy and Papageorgiou (2000), Moss (2000), Felipe and McCombie (2001), Graham (2001) and Kumbhakar (2003).

quantities of the factors of production. Technology can be assumed Hicks neutral (output augmenting) or can also be specified as Harrod neutral (labour augmenting).

In order to explain national productivity differences and to test the hypotheses in the introduction, we have carried out an econometric estimation of sectoral production functions, following Harrigan (1999). Our study extends Harrigan's contribution testing his model to the eight manufacturing sectors in eight European countries over the period 1978-1992 (a more homogenous sample than the one used by Harrigan).

The econometric procedure has the advantage of requiring assumptions that are less restrictive than international comparisons with TFP indices.

We assume that for each country *c* and year *t*, the real value added *y* of a sector *j* is a function of the stock of real physical capital and the quantity of labour :

$$y_{cjt} = f_{cjt}(k_{cjt}, l_{cjt}) = \beta_{cjt} * g_{cjt}(k_{cjt}, l_{cjt}) \qquad (2)$$

Considering that the technological differences are neutral in the sense of Hicks, β_{cjt} can be interpreted as an index of TFP. If we adopt the Cobb-Douglas functional form, we have:

$$\ln y_{cjt} = \ln \beta_{cjt} + \alpha_1 \ln k_{cjt} + \alpha_2 \ln l_{cjt} \qquad (3)$$

Introducing $\gamma = \alpha_1 + \alpha_2 - 1$ (where $\gamma + 1$ denotes the degree of returns to scale), subtracting $ln\ l_{ctj}$ from both sides of the equation, and reordering, we see that the value added per worker depends on the capital per worker, the total labour and the TFP:

$$\ln(y_{cjt} / l_{cjt}) = \ln \beta_{cjt} + \alpha_1 \ln(k_{cjt} / l_{cjt}) + \gamma \ln l_{cjt} \qquad (4)$$

Drawing on earlier studies, we will consider that the TFP varies between countries and over time, including country effects and time trends. More specifically, we will assume that the differences in TFP are common to the sectors of one and the same country and that the time trends are specific to each sector and common across countries, thereby obtaining the following statistical model:

$$\ln(y_{cjt} / l_{cjt}) = \beta_{0c} + \beta_{1j} t + \alpha_{1j} \ln(k_{cjt} / l_{cjt}) + \gamma_j \ln l_{cjt} + \varepsilon_{cjt} \qquad (5)$$

One of the problems that may arise is the cyclical variation in the use of productive capacity, this being caused by the non-proportional change of inputs and outputs in the short term which has its origin in the invariability of physical capital and the accumulation of labour factor.

To mitigate this the dependent variable was ajusted by the output gap, defined as μ = *observed GVA/potential GVA*[4]. In this way, the generic equation to be estimated takes the following form:

$$\ln(y_{cjt} / l_{cjt}) - \ln \mu_{ct} = \beta_{0c} + \beta_{1j} t + \alpha_{1j} \ln(k_{cjt} / l_{cjt}) + \gamma_j \ln l_{cjt} + \varepsilon_{cjt} \qquad (6)$$

We have estimated three models. The first (without restrictions) assumes different coefficients for each of the sectors in the exogenous technical progress (β_{1j}), elasticity of GVA with respect to capital (α_{1j}) and level of economies of scale ($1+\gamma_j$) variables, as well as a different average TFP for each country (β_{oc}).

In the second, the national variations in the production functions are maintained, but we have imposed constant returns to scale (γ_j=0).

The third model considers again the possibility of economies (diseconomies) of scale, at the same time as imposing the equality of the ($\beta_{oc} = \beta_0$) across countries.

[4] The potential GVA has been estimated by way of the Hodrick-Prescott filter applied to the GVA data for manufacturing corresponding to each country for the period 1978-1997 as this appears in the STAN data base

We have chosen the weighted least squares estimator, which is appropriate when there is unknown heteroscedasticity among individuals. The weightings are the inverses of the variances of the estimated equation and are obtained from the estimation without weightings of the parameters. Furthermore, the inclusion of the time trends makes improbable the existence of auto-correlation in the residuals. Nevertheless, a correlation between the explanatory variables and the error terms may remain, either due to measurement errors or because of simultaneity[5]. Although this problem is mitigated, in part, by correcting the phase of the cycle, the solution comes from working with instrumental variables. However, given that we have not been able to find appropriate instruments and that the incorrect introduction of them would give rise to additional distortions, we have decided to forgo this type of estimation.

3. THE DATA

The data of the gross value added (*GVA)*, physical capital and total employment used to estimate the model are drawn from the *International Sectoral Data Base* (ISDB) (1997) for all the sample countries, save for Spain. For this country, the GVA and employment data come from the *Structural Analysis Data Base* (STAN) (1998), and that of the physical capital variable from Mas, Pérez and Uriel (1998). It is certainly the case that the use of net capital stock would be a much more appropriate measurement to estimate the effects of technology in the increase of production, but unfortunately the OECD does not publish estimations for all the countries.

In order to compare the data of the different countries and years, we have homogenised the monetary units of the different countries with the purchasing power parity (PPP) of the GVA or of the gross formation of physical capital (in the case of the physical capital).

In order to adjust the labour productivity for the cycle, we have obtained the potential GVA by applying the Hodrick-Prescott (1997) filter, a smoothing methodology which allows us to obtain the long-term trend component of a series. With the aim of avoiding the possible inadequacy of the trend values in the final years of the sample, we have applied the filter for a longer period (1978-1997) than that used in the panel (1978-1992), following the recommendations of Scarpetta *et al*. (2000).

As total employment does not capture the force applied by labour, the equivalent to the number of workers that have worked a forty-hour week during the year has been calculated. The information on the effective hours per worker/week has been taken from the *Yearbook of Labour Statistics* of the International Labor Organisation.

A prior analysis of the data offers some interesting hypotheses to be tested. First, we see in Table 1 that in 1990 there was a considerable variation in labour productivity across sectors in the average of the countries analysed. We likewise observe that for each branch the ratio between the productivity of the country with the highest value and that of the country with the lowest oscillates between 2.55 and 1.31. These differences among countries which might be due to the behaviour of one of them, are also maintained (albeit in a somewhat smooth form) if we compare the data of France and Germany. The differences in labour productivity among countries are not compatible with the equality of productivities (and factor prices) predicted by the Neo-classical model.

[5] If, in the face of a productivity shock, there is an increase in the use of factors, this may be an indication of a strong positive correlation between employment and the error term.

Table 1
Sectoral productivity of manufacturing in 1990
(Average of the eight countries considered)

Sector	Participation in Manufacturing employment	GVA/employee (US dollars PPP)	Productivity ratios Max/min	France/Germany
Food	11.7%	42,188	1.6	1.0
Textile	10.3%	22,958	1.6	1.2
Paper	10.0%	37,060	1.3	1.2
Chemical	10.0%	57,154	2.0	1.3
Non-metalslic mineral	4.4%	40,417	2.1	1.4
Basic metalss industries	4.1%	48,046	2.6	1.2
Other manufacturing industries	8.9%	25,517	1.8	1.1
Mechanical industries	40.7%	33,748	2.1	1.2

Table 2 presents the correlation between the labour productivity of each pair of sectors in 1990, taking the countries as individuals. If the basic metalss industries are excluded, these coefficients are positive and indicate that labour productivity in one sector tends to be correlated with labour productivity in the other sectors.

Table 2
Correlation coefficients of labour productivity of the different sectors in 1990

Sector	Textile	Paper	Chemical	Non-metalslic minerals	Basic metalss industries	Other manufacturing industries	Mechanical Industries
Food	0.73	0.27	0.49	0.57	0.02	0.21	0.66
Textile		0.56	0.30	0.74	-0.38	0.65	0.77
Paper			0.28	0.74	-0.35	0.78	0.80
Chemical				0.76	-0.01	-0.23	0.44
Non-metalslic minerals					-0.36	0.43	0.84
Basic metalss industries						-0.51	-0.48
Other manufacturing industries							0.67

Table 3 offers the correlation between the capital/labour ratio in aggregate manufacture and the labour productivity of one sector in 1990, again taking the countries as individuals. In this case, the high coefficients indicate that those countries with a high capital intensity in total manufacturing similarly tend to have high capital intensity in most sectors. This contradicts the equality of the Neo-classical model, according to which those countries with a greater relative abundance of capital will specialise in more capital-intensive sectors (which does not predict that they will be more capital-intensive in all their sectors).

Finally, Table 4 reflects two manufacturing labour productivity indices for each country in 1990, taking the UK value as the base figure of 100. The first index is the result of calculating the average productivity of the country, weighing the productivity of each sector by the proportion of labour really used in it, whilst the second uses the proportion of labour used in France as the weighing for all countries. The country ranking proves to be the same, with the exception of Spain.

Table 3

Correlation coefficients between capital/labour ratio in the aggregate manufacture and the labour productivity of one sector in 1990

Sector	Coefficients
Food	0.90
Textile	0.83
Paper	0.76
Chemical	0.93
Non-metalslic minerals	0.64
Basic metalss industries	0.69
Other manufacturing industries	0.44
Mechanical industries	0.84

Table 4

Labour productivity indices in the aggregate manufacture in 1990

Country	Index 1	Index 2
France	159.1	154.6
Germany	138.2	132.4
Italy	135.4	131.9
Spain	134.9	139.7
Finland	123.1	119.5
Denmark	120.9	117.3
Sweden	109.9	109.2
United Kingdom	100.0	100.0

Notes: Index 1 has been calculated with the labour participation of the country itself.
Index 2 has been calculated with the labour participation of France.
In both cases, the United Kingdom has been taken as the base figure of 100.

The explanation for this similarity is that the national differences in aggregate labour productivity are due to differences in sectoral labour productivity rather than to discrepancies in the sectoral distribution of employment. Once again, this would appear to contradict the Neo-classical model, according to which national divergencies are due to disparities in the distribution of employment, which is orientated towards activities that are more capital or labour intensive, and not to systematic variations in sectoral productivity.

In short, the results invite us to estimate three alternative models when seeking to explain the variations in labour productivity across sectors and countries.

4. RESULTS

Table 5 contains the estimations of the three models specified on the basis of equation (6).

Those in the first two columns correspond to model 1 (non-restricted), which considers different coefficients for each sector in the four variables. According to this specification, the labour productivity of the sectors differs not only because countries have different TFPs (assuming that all the sectors of a given country have the same TFP) and distinct sectoral technical progress rates, but also because the levels of economies of scale and the elasticities of the GVA with respect to the capital also vary from sector to sector.

Indeed, these elasticities have values ranging between 0.101 in the chemical sector and 0.272 in other manufacturing industries. All the sectors present decreasing returns to scale and the rate of technical progress oscillates between 0.9% in the textile sector and 3.2% in basic metalss industries. Finally, the TFP of each country gives rise to a ranking that places France at its head, followed by Germany and Italy. The United Kingdom and Spain follow at some distance, whilst the Nordic countries of Denmark, Sweden and Finland occupy the final positions.

The fact of France occupying the first position (amongst the EU countries) is a result also obtained by Mas and Pérez (2000) when they estimated the production function for the total economy of various OECD countries (including the USA, which leads the TFPs).

Note that our model explains a larger percentage of sectoral product than that of Harrigan (1999) with a smaller range of values in the TFP. This would appear to indicate that when we estimate the model for broader industrial aggregations, the differences in the TFPs of the countries are reduced.

Here, we should bear in mind that Harrigan estimates his model with an imibalanced panel of data for the period 1981-1989 for countries such as Australia, Canada, Japan, Norway and the USA. These are countries whose economies not only differ significantly from those of Europe but also among themselves. This is the case both in the technologies employed as well as in the institutions and the endowments of certain variables not considered, such as infrastructures, human capital or economic size.

The second model assumes that the production (technology) function differs across countries, but imposes constant returns to scale as a restriction. These assumptions give rise to a generalised increase in the values of the elasticity estimated with respect to physical capital (with the sole exception of other manufacturing industries), which are now placed between 0.120 for basic metalss industries and 0.267 for the textile sector.

The rates of technical progress remain very similar to those of the earlier model and result in the same sectoral ranking. Furthermore, we can appreciate a relative improvement in the TFP of France with respect to Germany, followed by Italy and Denmark, with a second block composed by the United Kingdom, Sweden, Finland, and Spain. Once again, the range of values of the country TFPs is smaller than that reported by Harrigan (1999) although the coefficients of this variable continue to present high statistical significance.

The third model imposes the equality of the TFP across countries, although permitting non-constant returns to scale. It is supposed that the countries have equal production functions but use different techniques: the economies of scale do not lead to the equality of the productive factor prices and, as a consequence, different production technologies are employed even though the same production function is available. The estimation of the elasticity with respect to capital increases in all the sectors, now lying between 0.278 for the paper sector and 0.494 in mechanical industries. The rates of technical progress are again similar to those of the two earlier models and there appears to be a certain level of economies of scale in all the sectors except for basic metalss industries (whose coefficient has a reduced statistical significance).

The appearance of increasing economies of scale when excluding technological differences between countries is a result also obtained by Harrigan (1999) for the 1980s and for other countries in which the size effect is more evident (Canada, Japan, Australia), as well as by Maskus (1991) for 1984, using information for twenty eight countries and twenty eight sectors.

This result would appear to indicate that country size is related to economies of scale. When the fixed country effects (Model 3) are excluded, economies of scale appear, but when no restrictions are imposed in the coefficients (Model 1), the reduced sample with which we are working does not allow to distinguish the economies of scale and the country effects, giving negative coefficients (diseconomies of scale) to them. In support of our interpretation we can point to the fact that in Model 2 (in which constant returns to scale are imposed), the values of the country effects are more reduced than in Model 1[6].

In Table 6 we present the statistics that allow us to draw comparisons between the three models. According to the F-tests, the restrictions imposed in both Model 2 and Model 3 are rejected, but these two models cannot be compared. However, in order to make such a comparison we can make use of the *posterior odds ratios*[7].

[6] In Model 1 the decreasing economies of scale appear with negative coefficients so that, when excluding them from Model 2, they explain the lower value of the TFP in all the countries.

[7] For details of their development and a discussion, see Leamer (1983:157-159)

Table 5. Dependent variable: log (GVA per employee, adjusted by the use of capacity) Period 1978-1992. Estimation by weighted least squares

Logarithm of capital per employee	Model 1		Model 2		Model 3	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
Food	0.146	7.184	0.236	10.103	0.303	16.785
Textile	0.197	6.639	0.267	10.322	0.413	13.497
Paper	0.195	11.820	0.200	12.218	0.278	15.157
Chemical	0.101	5.053	0.194	9.813	0.284	13.198
Non-metalslic minerals	0.189	15.667	0.240	18.616	0.347	36.423
Basic metalss industries	0.118	4.533	0.120	3.549	0.295	16.093
Other manufacturing industries	0.272	10.896	0.231	10.191	0.355	21.494
Mechanical industries	0.194	6.673	0.259	11.635	0.494	17.553
Logarithm of employment	Model 1				Model 3	
	Coefficient	t-statistic			Coefficient	t-statistic
Food	-0.114	-7.662			0.114	19.821
Textile	-0.126	-10.802			0.031	4.886
Paper	-0.163	-8.348			0.100	7.930
Chemical	-0.119	-8.706			0.064	7.124
Non-metalslic minerals	-0.143	-10.397			0.060	13.598
Basic metalss industries	-0.193	-10.969			-0.020	-1.585
Other manufacturing industries	-0.223	-12.061			0.025	2.393
Mechanical industries	-0.161	-10.585			0.004	0.542
Exogenous technical progress	Model 1		Model 2		Model 3	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
Food	0.019	9.799	0.020	7.965	0.014	6.847
Textile	0.009	3.28	0.011	4.642	0.008	2.555
Paper	0.019	8.155	0.024	12.539	0.018	5.965
Chemical	0.028	14.145	0.027	12.98	0.025	9.671
Non-metalslic minerals	0.015	13.037	0.019	16.837	0.016	12.964
Basic metals industries	0.032	11.511	0.034	7.543	0.033	14.725
Other manufacturing industries	0.014	7.081	0.017	7.976	0.017	8.481
Mechanical industries	0.021	8.875	0.016	7.364	0.004	1.679
National fixed effects	Model 1		Model 2			
France = 100	Coefficient	t-statistic	Coefficient	t-statistic		
Germany	96.5	34.578	90.720	49.302		
France	100.00	35.21	100.00	48.359		
Italy	91.41	34.395	90.690	48.019		
Sweden	57.14	36.284	76.75	47.944		
United Kingdom	76.98	34.676	78.360	50.069		
Spain	72.05	35.426	70.570	52.265		
Finland	54.27	36.403	75.75	45.875		
Denmark	59.08	37.292	85.74	48.158		
Number of observations	900		900		900	
R^2	0.856		0.855		0.825	

Note: 1 plus the coefficient of the logarithm of employment indicates the degree of returns to scale.
So as not to overload the Table, the sectoral dummies has been omitted. Specific dummies have been introduced for Spain (to reflect that its data do not come from the ISDB) and for the other manufacturing industries sector in Italy (which also includes the Paper).

Table 6
Test statistics

F-tests	
Null hypothesis: Model 2	
F (8.860) = 5.298	Critical value at 1% = 2.51
Null hypothesis: Model 3	
F (7.860) = 28.900	Critical value at 1% = 2.64

Relative odd ratios	
Pr (model 2\data)/Pr(model 1\data) = 259.619	Model 2
Pr (model 3\data)/Pr(model 1\data) = 1.1302 E^{-31}	Model 1
Pr (model 2\data)/Pr(model 3\data) = 2.2972 E^{33}	Model 2

Note: All test statistics are calculated using the estimates of Table 5.

These ratios indicate that the data support Model 2 as compared to Model 1 and Model 3, whilst Model 1 has a better fit to the data than Model 3.

In slim, they show that to explain the behaviour of labour productivity it is necessary to include the assumption of different TFPs across countries. Bear in mind that this TFP reflects not only technology but also a number of variables that, with much less mobility, act in the national sphere and explain labour productivity. In any event, the results of our study are much more favourable to the constant returns hypothesis, given that Model 2 is preferred to Model 1, in clear contrast to Harrigan (1999) where the opposite is the case.

5. CONCLUSIONS

In this paper we have carried out a descriptive analysis of the data corresponding to the productive factors and gross value added of the different manufacturing branches of various EU Member States from the end of the 1970s until the beginning of the 1990s. A first conclusion that can be drawn is that there is a certain inadequacy in the prescriptions provided by the Neo-classical model of equality of productive factor prices. The differences found across countries in terms of sectoral labour productivity are such that they question the use of this model when seeking to explain the behaviour of this variable.

In turn, countries with relatively high labour productivity in one sector tend to exhibit it in all the sectors; similarly, a country with a relative abundance of capital tends to have greater capital intensity in all its manufacturing branches, against the model's forecast of specialisation in more capital intensive sectors. Furthermore, national differences in aggregate labour productivity are the result of national differences in sectoral productivity rather than of differences in the national distribution of employment between the different branches.

In the light of all this, we have proposed three models which combine different hypotheses on the existence of economies of scale and of technological differences across countries. Although the variation in labour productivity is explained, in great part, by the differences in capital intensity, the results nevertheless support the existence of a distinct TFP in the EU Member States.

Having said that, we must be aware of the fact that these differences in TFP can be interpreted not only as differences in the technology employed, but also as differences in national variables which have not been considered (such as infrastructures, legal and social institutions or human capital) or, simply, as measurement errors.

Given that technology is a factor capable of being transferred by way of multinational firms, technological transactions and imitation, our contention is that the technological differences of the countries analysed in this paper could be less relevant than the above-mentioned second type of national variables.

Consequently, economic policies must head for an improvement of human capital, of infrastructures, of the legal institutions that minimize transaction costs and the development of social capital as a catalyst of economic relations. Similarly, the generation of a national technological capital able to assimilate foreign technology or to develop new technological advances is another aspect to be encouraged so that a frame can be created that makes better conditions possible for growth to take place.

The challenge of future research rests on the improvement in the measurement of the variables used, as well as on the incorporation of new variables like human technological capital, infrastructures and social capital. The database which is currently being built within the Euklems project will no doubt allow a step forward in this respect.

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