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In the increasingly knowledge-based global economy, a well-educated and highly-skilled labour force and a significant degree of openness to international trade are vital for countries to successfully meet the challenge of worldwide competition. This paper is meant to provide empirical insights into the patterns of human capital endowments and international economic integration across Europe. By using a number of indicators capturing the main aspects of these variables, we perform a cluster analysis in an effort to show similarities and differences among the EU's 27 Member States.

Keywords: human capital, openness to international trade, economic growth

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1. Introduction

Economists have long been concerned with the determinants of long-term economic growth. It is nowadays widely accepted that technological progress, high levels of human capital and a significant degree of openness to international trade, knowledge flows and financial flows, play a major role in fostering growth, particularly in an increasingly knowledge-based global economy. No wonder, then, two striking examples of economies experiencing sharp increases in growth rates, China and India, have become large scale exporters of manufactured goods of growing sophistication and benefited from a well-educated and skilled labour force.

In this respect, the recent theoretical and empirical literature on economic growth has emphasized the relevance of intangible factors, mainly human capital diffusion and openness to international trade, in accounting for productivity growth. The aim of this paper is to shed more light on the determinants of growth and to provide a preliminary picture of the patterns of human capital endowments and trade integration across Europe. After a brief review of the main theoretical underpinnings, we perform a cluster analysis to show similarities and differences among the EU's 27 Member States in terms of human capital and international trade integration.

2. Human capital and trade as engines of growth

Over the recent years, the relationship between human capital, openness to international trade and economic growth has been explored to a great extent in literature. In this respect, the key contributions have been developed within the framework of endogenous growth theory. This strand of research embraces a diverse body of theoretical and empirical studies, emerged during the 1980s as a reaction to the neoclassical growth model. The new growth theories have provided persuasive intellectual support for the proposition that economic growth is sustained by knowledge, human capital and technological progress.

Romer's (1986) seminal paper paved the way for the new growth theory, by putting the emphasis on the process of accumulation of knowledge, whose spillovers across firms and individuals positively affects the long-run rate of growth. In the Lucas (1988) model, human capital has

come into prominence as a major source of growth in economies. By treating human capital as an ordinary input in the production function, Lucas shows how growth is driven by the accumulation of knowledge and skills embodied in individuals. In this way, differences in growth rates across countries are assumed to be primarily due to differences in the rates of human capital accumulation.

In contrast to Lucas's assumption, other scholars relate growth to the level of human capital. Romer (1990) finds that economies with a larger total stock of human capital experience more rapid rates of technical progress and productivity growth. In this model, endogenous growth is ultimately dependent on technical progress driven by private investment in research and development (R&D). R&D activities are assumed to give rise to new designs and products which generate temporary monopoly rents. These rents provide the financial incentives to innovate and to cover the cost of innovation. In this light, the stock of human capital employed in research activities determines the capacity of nations to innovate and does lie at the heart of economic growth. Similarly, Benhabib and Spiegel (1994; 2005) emphasize the role of the stock of human capital, which affects both a country's ability to innovate and its speed of technological catch-up and diffusion. This model builds on Nelson and Phelps (1966), whose major contribution was to suggest that the rate at which the gap between the world technology frontier, represented by the country leader, and the follower's level of productivity is closed depends on the stock of domestic human capital. The presumption behind these approaches is that an educated labour force is not only better at creating new technologies, but also at adopting and implementing technological advances from abroad. Accordingly, for Benhabib and Spiegel the stock of human capital affects growth through two mechanisms: it directly influences the rate of domestically produced technological innovations while speeding up the process of technological catch-up with more advanced countries. The significance of this model in both theoretical and empirical terms is that growth rates differ across countries due to differences in levels, rather than growth rates, of human capital stocks.

In the wake of these findings, a number of attempts to trace the combined role of human capital and technology diffusion in economic growth has been made since. Grossman and Helpman (1991) and Barro and Sala-i-Martin (1995) have argued that countries that are more open to international trade have a greater ability to absorb innovations generated in leading nations. By considering a two-countries world (one advanced and one poorer), Barro and Sala-i-Martin (1995, Ch. 8) find that the rate of growth in the developing country depends on the cost of imitation of innovations produced in the leading nation, and on its initial stock of knowledge. Intuitively, the model predicts that poorer countries may grow faster if they adopt more foreign technology by opening up to international trade.

The existence of a positive correlation between a country's degree of openness to international exchange and its growth performance is a well-documented empirical regularity, that is almost universally accepted by economists. Grossman and Helpman (1991, Ch. 9) describe four distinct mechanisms by which countries adopting outward-oriented policies experience rates of growth and technical progress much greater than those achievable with inward-oriented policies. First, as discussed above, international trade opens channels of communication that facilitates the exchange of technical information on innovative products and novel methods of production. Secondly, by introducing competition between firms in different countries, trade gives entrepreneurs in each location a strong incentive to pursue new and distinctive ideas and technologies. Third, economic integration enlarges the size of the market available to any producer. Finally, the opening of trade between countries induces distinct patterns of specialization in different manufacturing activities for each trading partner.

In this wake, Rivera-Batiz and Romer (1991) have outlined two channels for the transfer of technological knowledge: the transmission of ideas which can be traded independently from

goods, and the trade of capital goods (machinery and equipment) that embody new knowledge. In their model, both international knowledge flows raise growth.

The new paradigm of endogenous growth has spurred a spate of research that tried to test empirically the contribution of these factors to total factor productivity growth. Over the 1990s, the conviction that human capital was good for growth was fostered by a number of cross-country studies (e.g. Barro 1991, 1997; Gemmell 1996; Benhabib and Spiegel 1994), though there exists a number of empirical studies that are sometimes inconsistent with this expectation (Pritchett 1996). Similarly, economic literature has explored directly the quantitative relationship between trade openness and the level and growth of per capita GDP. Several empirical studies (to name a few, Dollar 1992; Sachs and Warner 1995; Edwards 1998) found that increased economic integration between countries has tended to increase the long-run rate of economic growth.

Stemming from these findings, this paper performs a cluster analysis to highlight how human capital is distributed in Europe and to what degree European countries are open to international trade.

3. Data and methodology

In this section, our goal is to identify the empirical patterning of human capital stocks and openness to trade across Europe. In line with the main findings of the endogenous growth literature, one could put forward the argument that countries that fare well in terms of human capital endowments and trade integration today are expected to exhibit rising GDP levels in the coming years. Can European countries be clustered according to the extent to which they have high or low levels of human capital or are more or less integrated with world markets? Can we detect any particular pattern among the data? To answer these questions, we apply an explanatory technique – cluster analysis – in order to partition European countries into homogeneous subgroups without any constraints or *a priori* information. In this respect, cluster analysis attempts to organize variables into distinct groups based on a statistical measure of their distance from each other.

In order to operationally define and loose concepts such as human capital and trade integration, the analysis includes 15 indicators to reflect the multi-faceted dimensions of these variables²⁹³. The data for this exercise come from the Eurostat²⁹⁴ database and the World Bank²⁹⁵ database and mainly refer to year 2006²⁹⁶. The dataset covers all the 27 EU Member States.

Variables are normalised into a range of 0 and 1 prior to the analysis to account for different variances according to the measurement level. In the clustering process, we use the agglomerative hierarchical method that merges any element into successively larger clusters

293 Eight indicators are used for the human capital domain: Graduates (ISCED 5-6) in maths, science and technology fields as a percentage of all fields; Ratio of students to teachers (ISCED 1-3); Total public expenditure on education (all levels of education combined) as a percentage of GDP; Students (ISCED 1-6) by sex aged 15-24 years as a percentage of the corresponding age population; Average number of foreign languages learned per pupil at ISCED level 3; Total R&D personnel as a percentage of total employment; Annual expenditure on public and private educational institutions per pupil/student; Gross tertiary school enrollment. Seven indicators are selected to account for the degree of openness to international trade: Foreign Direct Investment (FDI) intensity (calculated as the average value of inward and outward FDI flows divided by GDP - in percent); Imports of high technology products as a share of total imports; Exports of high technology products as a share of total exports; Computer, communications and other services as a percentage of commercial service imports; Computer, communications and other services as a percentage of commercial service exports; Exports of goods and services as a percentage of GDP; Imports of goods and services as a percentage of GDP.

294 <http://ec.europa.eu/eurostat>.

295 <http://www.worldbank.org/data/onlinebases/onlinebases.html>.

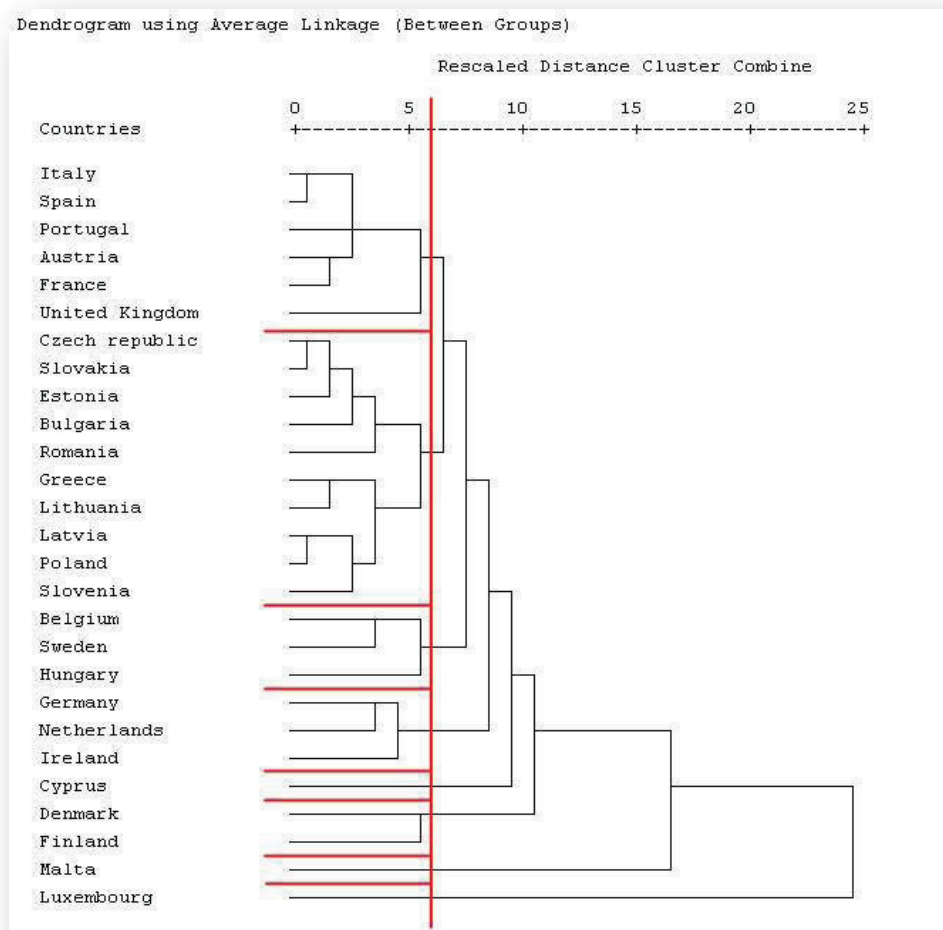
296 Data from 2006 are not available for three indicators (Total public expenditure on education as a percentage of GDP, Total R&D personnel as a percentage of total employment, Annual expenditure on public and private educational institutions per pupil/student), for which we consider the data collected in 2005.

combined sequentially until one single cluster is constructed. Euclidean distances are calculated to measure distance for the observed data. The average (between groups) linkage method is used to find reasonable cluster solutions. The traditional representation of this hierarchy is a clustering tree called dendrogram, under which the y-axis plots the objects of study (European countries) in descending order of similarity and the x-axis denotes the linkage distance among groups. The larger the index printed on the horizontal axis, the more differences can be observed between countries or clusters of countries.

4. Results

Figure 1 shows the cluster results in the form of the dendrogram that represents the similarities and differences concerning the distribution of human capital and the degree of openness to international trade across European countries. The final cluster solution suggests five distinct and fairly homogenous clusters in this broad sample of countries, by cutting the tree at the index value of about 6 points.

Fig. 1 - Clusters of human capital and trade integration in Europe



The first cluster is composed of countries (Italy, Spain, Portugal, Austria, France and the United Kingdom) that are very similar as they merge at a very early stage of the process. This is a very homogeneous block of Western European countries which show values of human capital stocks ranging from medium to high and low levels of trade integration (they exhibit low values on trade

as a share of GDP). The picture changes somewhat when considering the second cluster, made up of Eastern European countries (Czech Republic, Slovakia, Estonia, Bulgaria, Romania, Lithuania, Latvia, Poland and Slovenia) and Greece. This fairly similar grouping claims the bulk of Eastern Europe, which are low on the measures of human capital and average on the degree of trade openness. Cluster 3 includes three geographically non-proximate countries (Belgium, Sweden and Hungary), which score highly in terms of international trade integration and expenditure in education – though they show mixed results as to the other indicators of human capital diffusion. A similar pattern emerges in the fourth cluster. This grouping contains Germany, the Netherlands and Ireland, with medium to high levels of both human capital indicators and openness to trade. Cluster 5 consists of two Nordic countries, such as Denmark and Finland, which are high on human capital and average to high on trade integration. Not all the Member States are clustered within the five groups: Cyprus, Malta and Luxembourg are outliers.

5. Conclusive remarks

The arguments presented above suggest economists place a large emphasis on human capital and openness to international trade as determinants of growth. We have performed a cluster analysis to determine similarities and differences among European countries in this respect. The analysis shows that there are five distinct clusters showing different patterns of human capital diffusion and international integration across Europe. Clearly, the results leave open the question as to whether, and to what extent, these variables affect economic growth. Future research may want to address whether human capital and trade integration can be given a causal interpretation in the growth process.

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