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The Competitiveness of Nations:

Economic Growth in the ECE Region

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Abstract

Why do some countries grow much faster, and have much better trade performance, than other countries? What are the crucial factors behind such differences, and what can governments do in order to improve the relative position of their economies? This paper outlines a synthetic framework, based on Schumpeterian logic, for analysing such questions. Four different aspects of competitiveness are identified; technology, costs, capacity and demand. The framework is applied to a sample of 49 countries between 1993 and 2001.

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1. Introduction

Why do some countries grow so much faster, and have much better trade performance, than other countries? What are the crucial factors behind such differences? Which policies can governments pursue to improve the relative performance of their economies (and welfare of its citizens)? These are the kind of questions that motivate a concern for the competitiveness of countries. Although the concept as such has been strongly criticized by some theoreticians, the importance of the underlying challenges makes it unlikely that this issue will lose the attention of policy makers soon.[1]

We begin the paper with a few reflections on the concept of competitiveness and its use. First, the concept is applied on several levels. What has been the prime focus of the debate, and what we will focus on here, is when applied to a country. Second, it is a relative term. What is of interest is not absolute performance, however that may be defined, but how well a country does relative to others. Some dislike this comparative perspective. But, after all, this is a perspective that we find in nearly all aspects of social life, work, sports, business etc., among individuals as well as collectives. So why not at the level of countries? We see no compelling reason not to use the concept at that level. Third, when applied to a country, it has a double meaning, it relates both to the economic well-being of its citizens, normally measured through GDP per capita, and the trade performance of the country.[2] The underlying assumption, then, is that these things are intimately related. This is perhaps not so controversial in itself, but the precise nature of this relationship may of course be. In the next section we outline an analytical framework, based on Schumpeterian logic, which among other things explains why, in analyses of competitiveness, it is indeed natural to focus on both GDP and trade performance and their mutual relationship.

Arguably, the discussion of the competitiveness issue has been much obscured by a common tendency among many economists to focus on extremely simplified representations of reality that abstracts from the very facts that make competitiveness an important issue for policy makers and other stakeholders in a country. A well-known example of this is the idea of "perfect competition", which among other things presupposes that all agents have access to the same body of knowledge, produce goods of identical quality and sell these in price-clearing markets, so that the only thing left to care about is to get the price right. For a long time this led applied economists and analysts to focus on price as the only aspect of competitiveness. Joseph Schumpeter long ago described the short-comings of such simplifications. The true nature of capitalist competition, he argued, is not price competition, as envisaged in traditional text- books, but technological competition:

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[1] For a critique of the concept see, for example, P. Krugman, "Competitiveness: A dangerous obsession", *Foreign Affairs*, Vol. 73, 1994, pp. 28-44. For an extended discussion see J. Fagerberg, "Technology and Competitiveness", *Oxford Review of Economic Policy*, Vol. 12, 1996, pp. 39-51, reprinted as chapter 16 in J. Fagerberg, *Technology, Growth and Competitiveness: Selected Essays* (Cheltenham, Edward Elgar, 2002).

[2] There are many definitions around, most of which reflect this "double meaning" in one way or another. A typical example is the following: Competitiveness is "the degree to which, under open market conditions, a country can produce goods and services that meet the test of foreign competition while simultaneously maintaining and expanding domestic real income" see OECD, *Technology and the economy: The key relationships* (Paris, OECD, 1992, pg. 237).

> "But in capitalist reality as distinguished from its textbook picture, it is not that kind of competition that counts but the competition from the new commodity, the new technology, the new source of supply, the new type of organization (…) - competition which commands a decisive cost or quality advantage and which strikes not at the margins of the profits and the outputs of the existing firms but at their foundations and their very lives."[3]

In this paper we depart from the "perfect competition" approach and the idea of technology as a public good. Rather, following Dosi and others, we assume that technology is cumulative and context dependent in ways that prevent the economic benefits of innovation to spread more or less automatically.[4] This more realistic approach to the role of technology in economic change does not prevent diffusion from being a powerful factor behind growth and competitiveness in so-called latecomer countries.[5] On the contrary we side with the economic historian Gerschenkron in his suggestion that the technological gap between a frontier and a latecomer country represents "a great promise" for the latter, since it provides the latecomer with the opportunity of imitating more advanced technology in use elsewhere.[6] However, just as he and others have done, we stress the stringent requirements for getting the most out of such opportunities.[7] In fact, this holds not only for latecomer countries, but also for countries closer to or on the frontier, since similar considerations apply for the successful commercialisation all new technologies, independent of where it was first developed. We use the term "capacity competitiveness" for this aspect of the competitiveness of a country, which we suggest to consider in addition to the two other aspects – technology and price competitiveness – mentioned above. Finally, following one of the suggestions in the literature on competitiveness (see the next section), we also take into account the ability of a country to exploit the changing composition of demand, by offering attractive products that are in high demand at home and abroad. We label this (fourth) aspect "demand competitiveness".

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[3] J. Schumpeter, *Capitalism, Socialism and Democracy* (New York, Harper, 1943), p. 84.

[4] G. Dosi, "Sources, Procedures and Microeconomic Effects of Innovation", *Journal of Economic Literature*, Vol. 26, 1988, pp. 1120-71.

[5] J. Fagerberg and M. Godinho, "Innovation and catching-up", in J. Fagerberg, D. Mowery and R. Nelson (ed.), *Oxford Handbook of Innovation* (Oxford, Oxford University Press, 2004), forthcoming.

[6] A. Gerschenkron, Economic Backwardness in Historical Perspective (Cambridge, Mass, The Belknap Press, 1962).

[7] See, for example, M. Abramovitz, "Catching Up, Forging Ahead, and Falling Behind", *Journal of Economic History*, Vol. 46, 1986, pp. 386-406, and M. Abramovitz, "The Origins of the Postwar Catch-Up and Convergence Boom", in J. Fagerberg, B. Verspagen and N. von Tunzelmann (ed.), *The Dynamics of Technology, Trade and Growth* (Aldershot, Edward Elgar, 1994), pp. 21-52.

2. A synthetic framework

We start by developing a very simple growth model based on Schumpeterian logic, which we will subsequently extend and refine.[8] Assume that the GDP of a country (Y) is a multiplicative function of its technological knowledge (Q) and its capacity for exploiting the benefits of knowledge (C), and a constant (A_1):[9]

$$(1) \qquad Y = A_1 Q^{\alpha} C^{\beta} \qquad (\alpha, \beta > 0)$$

Its technological knowledge, in turn, is assumed to be a multiplicative function of knowledge diffused to the region from outside (D) and knowledge (or innovation) created in the country (N) and, again, a constant (A_2):

$$(2) \qquad Q = A_2 D^{\gamma} N^{\lambda} \qquad (\gamma, \lambda > 0)$$

Assume further, as common in the 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 country and that of the country on the technological frontier (for the frontier country, this contribution will be zero by definition). Let the total amount of knowledge, adjusted for differences in size of countries, in the frontier country and the country under consideration, be T_* and T, respectively:

$$(3) \qquad d = \phi - \phi \frac{T}{T_*} \qquad (\phi > 0)$$

By differentiating (2), using small case letters for growth-rates, and substituting (3) into it, we arrive at the following expression for the growth of a country's technological knowledge:

$$(4) \qquad q = \gamma\phi - \gamma\phi \frac{T}{T_*} + \lambda n$$

By differentiating (1) and substituting (4) into it we get the country's rate of growth:

$$(5) \qquad y = \alpha\gamma\phi - \alpha\gamma\phi \frac{T}{T_*} + \alpha\lambda n + \beta c$$

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[8] This section draws on J. Fagerberg, "The dynamics of technology, growth and trade: A Schumpeterian perspective", in H. Hanusch, and A. Pyka (ed.), *Elgar Companion to Neo-Schumpeterian Economics* (Cheltenham, Edward Elgar), forthcoming.

[9] Instead of seeing the model (1)-(6) as a model of GDP growth, one might consider it as a model of GDP per capita (worker) growth, in which case all variables would enter on a per capita (worker) basis. The first applications of the model was based on the former assumption, applied here, while later applications, for instance on regional growth, have generally assumed the latter. The relationship between the two versions of the model is straightforward. Note, however, that if the latter assumption is chosen, population (or labour force) growth would enter into the determination of GDP growth.

Since our primary interest is in "why growth differs" it may be useful to express the rate of growth of the country in relative terms (growth relative to the world average), y_{rel}[10]:

$$(6) \qquad y_{rel} = y - w = -\alpha\gamma\phi\frac{T - T_w}{T_*} + \alpha\lambda(n - n_w) + \beta(c - c_w)$$

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

- The potential for exploiting knowledge developed elsewhere,
- Creation of new knowledge in the country (innovation), and
- Growth in the capacity to exploit the potential entailed by knowledge (independently of where it is created).

This model, simple as it is, encompasses many of the empirical models found in the literature. For instance, the empirical models used in the "catching-up" literature can be seen as a version of (5)-(6) in which the innovation term is ignored.[11] Fagerberg applied the above model to a sample of developed and medium-income countries. It was shown that countries that caught up very fast, also had very rapid growth of innovative activity. The analysis suggested that superior growth in innovative activity was the prime factor behind the huge difference in performance between Asian and Latin-American NIC-countries in the 1970s and early 1980s.[12] It has also been shown that the continuing rapid growth of the Asian NICs relative to other country groupings in the decade that followed was primarily caused by the rapid increases in its innovative performance.[13] Moreover, estimations of the model for different time periods indicate that while imitation has become more demanding over time (and hence more costly to undertake), innovation has become a more powerful factor in explaining observed differences in growth performance.[14]

The model opens up for international technology flows but abstracts from flows of goods and services. We will now introduce the latter. For simplicity we do this in a two-country framework, in which the other country is labelled "world". Define the share of a country's exports (X) in world demand (W) as $S_x = X / W$, and similarly the share of imports (M) in its own GDP (Y) as $S_m = M / Y$. For the sake of exposition we assume that the market shares of a country are unaffected by the growth of the market, but we will relax this assumption later.

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[10] This is based on the assumption that the two countries face the same competitive conditions (elasticities) but vary in other respects.

[11] See, for example, W. J. Baumol, S. A. Batey Blackman and E. N. Wolff, *Productivity and American Leadership: The Long View* (Cambridge, Mass., MIT Press, 1989).

[12] J. Fagerberg, "Why Growth Rates Differ," in G. Dosi, et al. (ed.), *Technical Change and Economic Theory* (London, Pinter, 1988), pp. 432-457.

[13] J. Fagerberg, and B. Verspagen, "Technology-Gaps, Innovation-Diffusion and Transformation: An Evolutionary Interpretation", *Research Policy*, Vol. 31, 2002, pp. 1291-1304.

[14] J. Fagerberg, "A Technology Gap Approach to Why Growth Rates Differ", *Research Policy*, Vol. 16, 1987, pp. 87-99, reprinted as chapter 1 in J. Fagerberg, *Technology, Growth and Competitiveness: Selected Essays* (Cheltenha,: Edward Elgar, 2002), and J. Fagerberg, and B. Verspagen, "Technology-Gaps, Innovation-Diffusion and Transformation: An Evolutionary Interpretation", *Research Policy*, Vol. 31, 2002, pp. 1291-1304.

Following the Schumpeterian logic outlined in the previous section, we will assume that, apart from a constant-term, a country's market share for exports depends on three factors; its technological competitiveness (its knowledge assets relative to competitors), its capacity to exploit technology commercially (again relative to competitors) and its price (P) competitiveness (relative prices on tradables in common currency):

$$(7) \qquad S_x = A_3\left(\frac{Q}{Q_W}\right)^{\rho}\left(\frac{C}{C_W}\right)^{\mu}\left(\frac{P}{P_W}\right)^{-\pi} \qquad (\rho, \mu, \pi > 0)$$

Since, by definition, imports in this model are the "world"'s exports, we may model the import share in the same way, using bars to distinguish the coefficients of the two equations:

$$(8) \qquad S_M = A_4\left(\frac{Q_W}{Q}\right)^{\bar{\rho}}\left(\frac{C_W}{C}\right)^{\bar{\mu}}\left(\frac{P_W}{P}\right)^{-\bar{\pi}} \qquad (\bar{\rho}, \bar{\mu}, \bar{\pi} > 0)$$

By differentiating (7) and substituting (4) into it, and similarly for (8), we arrive at the dynamic expressions for the growth in market shares:

$$(9) \qquad s_X = -\rho\gamma\phi\frac{T - T_W}{T_*} + \rho\lambda(n - n_W) + \mu(c - c_W) - \pi(p - p_W)$$

$$(10) \qquad s_M = -\bar{\rho}\gamma\phi\frac{T_W - T}{T_*} + \bar{\rho}\lambda(n_W - n) + \bar{\mu}(c_W - c) - \bar{\pi}(p_W - p)$$

We see that the growth of the market share of a country depends on four factors:

- The potential for exploiting knowledge developed elsewhere, which depends on the country's level of technological development relative to the world average.
- Creation of new knowledge (technology) in the country (innovation) relative to that of competitors.
- Growth in the capacity exploit knowledge, independently of where it is created, relative to that of competitors.
- Change in relative prices in common currency.

Following earlier contributions by Thirlwall and Fagerberg we now introduce the requirement that trade in goods and services has to balance (if not in the short, so in the long run).[15] Countries may, however, have foreign debts (or assets). As is easily verified, we may multiply the left or right hand side of (11) with a scalar without any consequence for the subsequent deductions. Hence an alternative way to formulate this restriction might be that

[15] A. P. Thirlwall, "The Balance of Payments Constraints as an Explanation of International Growth Rate Differences", *Banca Nazionale del Lavoro Quarterly Review*, No. 32, 1979, pp. 45-53, and J. Fagerberg, "International Competitiveness", *Economic Journal*, Vol. 98, 1988, pp. 355-374, reprinted as chapter 12 in J. Fagerberg, *Technology, Growth and Competitiveness: Selected Essays*, (Cheltenham, Edward Elgar, 2002).

the deficit (surplus) used to service foreign debt (derived from assets abroad) should be a constant fraction of exports (or imports).

(11) $XP = MP_W$

By differentiating (11), substituting S_X and S_M into it and rearranging we arrive at the dynamic form of the restriction:

(12) $y = (s_X - s_M) + (p - p_W) + w$

This assumption has been extensively tested on data for developed economies and found to hold well.[16]

By substituting (9)-(10) into (12) and rearranging we get the reduced form of the model:

(13) $y_{rel} = -(\rho + \overline{\rho})\gamma\phi \frac{T - T_W}{T_*} + (\rho + \overline{\rho})\lambda(n - n_W) + (\mu + \overline{\mu})(c - c_W) + [1 - (\pi + \overline{\pi})](p - p_W)$

By comparing this equation with the similar reduced form of the growth model (6) we see that, apart from the last term on the right hand side, the model has the same structure. The only difference is that the coefficients of the basic growth equation now are shown to be sums of coefficients for the similar variables in the market-share equations (for the domestic and world market). Hence, the sensitivity of the markets (or "selection environments") for new technologies clearly matters for growth. The final term is the familiar Marshall-Lerner condition which states the sum of the price-elasticities for exports and imports (when measured in absolute value) has to be higher than one if deteriorating price-competitiveness is going to harm the external balance (and – in this case – the rate of growth of GDP).

We have modelled the market share equations on the assumption that, when not only price, but also technology and capacity have been taken into account as competitive factors, demand may be assumed to have a unitary elasticity. This means, for instance, abstracting from other factors, that if export demand grows by a certain percentage, exports will do the same, so that the market share remains unaffected. However, there are reasons to believe that this assumption, although appealing in its simplicity, does not necessarily hold in reality. For instance, it has been argued that if a country has a pattern of specialization geared towards industries that are in high (low) demand internationally its exports may grow faster (slower) than world demand, quite independently of what happens to other factors.[17] This way of reasoning, distinctly Keynesian in flavour, place more emphasis on the growth world demand, and on the "income elasticities of demand" for a country's exports and imports, in

[16] J. Fagerberg, "International Competitiveness", *Economic Journal*, Vol. 98, 1988, pp. 355-374, reprinted as chapter 12 in J. Fagerberg, *Technology, Growth and Competitiveness: Selected Essays*, (Cheltenham, Edward Elgar, 2002), and V. Meliciani, *Technology, Trade and Growth in OECD countries – Does Specialization Matter?* (London, Routledge, 2001).

[17] A. P. Thirlwall, "The Balance of Payments Constraints as an Explanation of International Growth Rate Differences", *Banca Nazionale del Lavoro Quarterly Review*, No. 32, 1979, pp. 45-53, and N. Kaldor, "The Role of Increasing Returns, Technical Progress and Cumulative Causation in the Theory of International Trade and Economic Growth", *Economie Applique* (ISMEA), Vol. 34, 1981, pp. 593-617.

determining a country's growth performance.[18] The higher the income elasticity of exports relative to that of imports, it is argued, the higher the rate of growth will be, and vice versa. Arguably, this might be expected to be of greatest relevance for small countries, since these are likely to be more specialised in their economic (and trade) structure than large ones. To take this possibility into account we, following Fagerberg, introduce demand in the market shares equations:[19]

$$(7') \qquad S_x = A_3\left(\frac{Q}{Q_w}\right)^{\rho}\left(\frac{C}{C_w}\right)^{\mu}\left(\frac{P}{P_w}\right)^{-\pi} W^{\tau-1} \qquad (\tau > 0)$$

$$(8') \qquad S_m = A_4\left(\frac{Q_w}{Q}\right)^{\bar{\rho}}\left(\frac{C_w}{C}\right)^{\bar{\mu}}\left(\frac{P_w}{P}\right)^{-\bar{\pi}} Y^{\bar{\tau}-1} \qquad (\bar{\tau} > 0)$$

By differentiating and substituting we arrive at the following expression for the reduced form:

$$(13') \quad y_{rel} = -\frac{(\rho+\bar{\rho})}{\bar{\tau}}\gamma\phi\frac{T-T_W}{T_*} + \frac{(\rho+\bar{\rho})}{\bar{\tau}}\lambda(n-n_W) + \frac{(\mu+\bar{\mu})}{\bar{\tau}}(c-c_W) + \frac{1-(\pi+\bar{\pi})}{\bar{\tau}}(p-p_W) + \frac{\tau-\bar{\tau}}{\bar{\tau}}w$$

The first thing to note is that the higher the demand elasticity for imports, the lower the effect on growth of all other factors. The second is, as before, that while the first three terms on the right hand side resembles the basic growth model (6), the two last terms in (13') resemble the model suggested by Thirlwall.[20] Hence, both the basic model (6) and Thirlwall's model can be seen as special cases of a more general, open-economy model.[21]

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[18] The income elasticity of exports is the growth in exports resulting from a 1% increase in world demand, holding relative prices constant (and ignoring cyclical factors). Similarly for imports.

[19] J. Fagerberg, "International Competitiveness", *Economic Journal*, Vol. 98, 1988, pp. 355-374, reprinted as chapter 12 in J. Fagerberg, *Technology, Growth and Competitiveness: Selected Essays*, (Cheltenham, Edward Elgar, 2002).

[20] A. P. Thirlwall, "The Balance of Payments Constraints as an Explanation of International Growth Rate Differences", *Banca Nazionale del Lavoro Quarterly Review*, No. 32, 1979, pp. 45-53.

[21] If the demand elasticities are the same in both markets and the Marshall-Learner conditions is exactly satisfied (or relative prices do not change), the two last terms vanish, and we are back in a model that for all practical purposes is identical to (6). If, on the other hand, the country's technological level is exactly average and both relative technology and relative capacity keep constant, the three first terms vanish, and only Thirlwall's model remains.

3. *The competitiveness of the countries of the ECE region 1993 – 2001: the "stylized facts"*

Fagerberg applied the above open-economy model to data for developed (OECD) economies.[22] Between 1960 and 1983, the results generally confirmed the importance of growth in technological and productive capacity for competitiveness. The impact of price or cost factors was found to be relatively marginal, consistent with the earlier findings by Kaldor (the so-called Kaldor paradox).[23] Recently, Meliciani has applied the model to a longer time series, including a more recent time period, with broadly similar results.[24] In this paper we move significantly beyond these previous empirical applications of this perspective. First we consider a much broader sample, 49 countries, characterized by very different development levels and trends, for a more recent (though shorter) time span (1993-2001). The sample consists of all ECE countries for which data were available, supplemented by some Asian and Latin American countries. The non-member countries were included partly for a comparative purpose, but also because some these countries during the last few decades have become very important players in the global economy. Second, and of even greater importance, we develop much more sophisticated indicators of the various aspects that together determine the overall competitiveness of a country. This is particularly the case for "technology competitiveness" and "capacity competitiveness", both of which are multidimensional in character and consequently hard to measure. But we also develop a new indicator of "demand competitiveness" that in a better way captures the underlying ideas behind the inclusion of this particular dimension.

Figure 1 presents some basic data on development levels and trends for the countries included into our investigation. While the vertical axis measures average productivity or income over the period (GDP per capita in PPPs in 1997), the horizontal axis reports annual average growth over the period (1993-2001). By combining these two aspects, level and trend, four different quadrants emerge. First, to the upper left we have countries with a high level GDP per capita but relatively slow growth, e.g., countries that "lose momentum". The USA, Japan and Switzerland are the prime examples. In contrast, in the upper left quadrant, we have countries that continue to grow fast despite a high level of GDP per capita ("moving ahead"). The most spectacular example is Ireland; other countries included in this more

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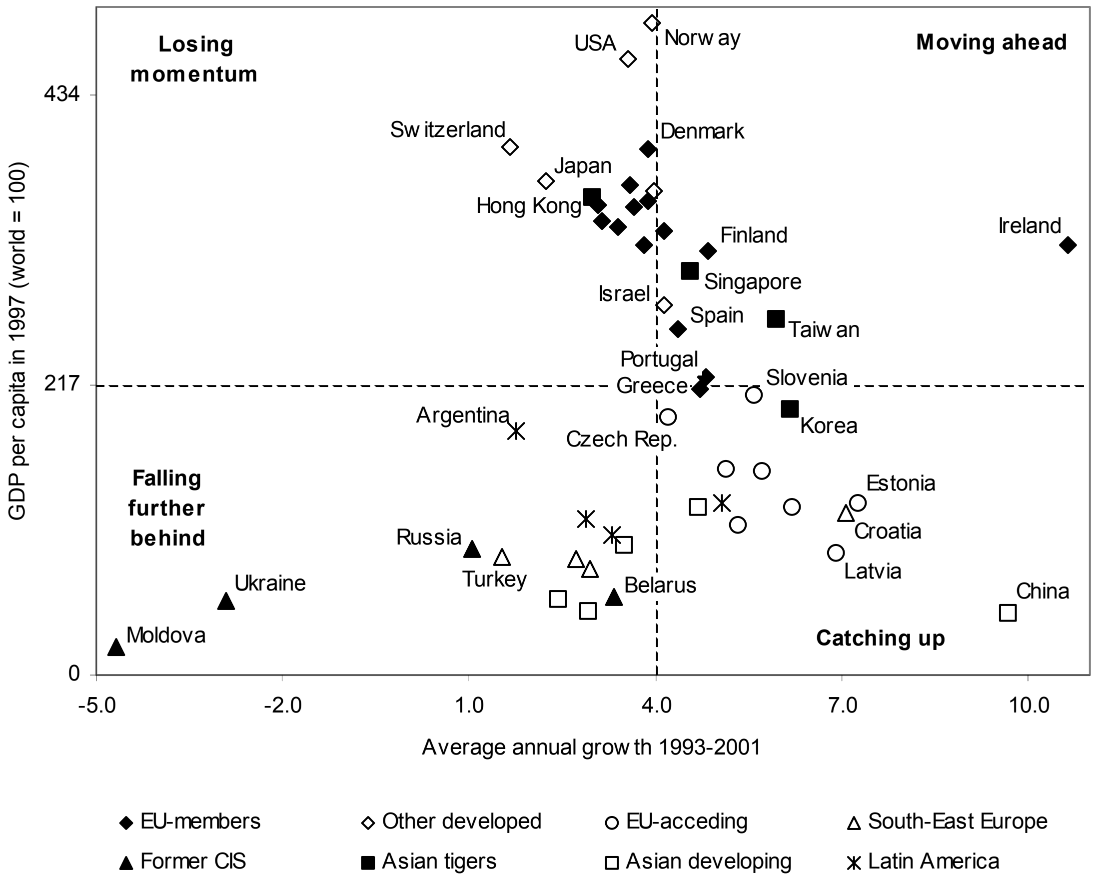
[22] J. Fagerberg, "International Competitiveness", *Economic Journal*, Vol. 98, 1988, pp. 355-374, reprinted as chapter 12 in J. Fagerberg, *Technology, Growth and Competitiveness: Selected Essays*, (Cheltenham, Edward Elgar, 2002).

[23] Kaldor showed for a number of countries that over the long term market shares for exports and relative unit costs or prices tend to move together, i.e., that growing market shares and increasing relative costs or prices tend to go hand in hand – see N. Kaldor, *The effect of devaluations on trade in manufactures, in Further Essays on Applied Economics* (London, Duckworth, 1978). This was, of course, the opposite of what you would expect from the simplistic though at the time widely diffused approach focusing exclusively on the (assumedly negative) impact of increasing relative costs or prices on market shares, hence the term "paradox". Fagerberg has shown that this finding also applies to a more recent time period – see J. Fagerberg, "Technology and Competitiveness", *Oxford Review of Economic Policy*, Vol. 12, 1996, pp. 39-51, reprinted as chapter 16 in J. Fagerberg, *Technology, Growth and Competitiveness: Selected Essays* (Cheltenham, Edward Elgar, 2002).

[24] Meliciani also added a "specialization" variable, reflecting the extent to which countries were specialized in technologically progressive sectors, to the market share equations, for which she found empirical support – see V. Meliciani, *Technology, Trade and Growth in OECD countries – Does Specialization Matter?* (London, Routledge, 2001).

dynamic category are Finland, Singapore and Taiwan. However, most developed countries, including all the remaining EU members, cluster on the borderline between "losing momentum" and "moving ahead", indicating a growth performance close to the average of the sample.

Figure 1: Overall Competitiveness (GDP per capita, current US dollars in PPP)



Source: Own computations based on the World Bank (World Development Indicators).

Of particular interest is the performance of the poorer economies, those in the lower half of the graph. Here we see a very clear distinction between those that are "catching up" (in the lower right) and those that are "falling further behind" (in the lower left). The former, those that appear to be on a "catching up" trajectory, include all the new EU members (joined by Croatia), three Asian countries (China, Korea and Malaysia) and Chile. In sharp contrast to this favourable development, all the countries in our sample that formerly belonged to the Soviet Union (Belarus, Russia, Ukraine and Moldova), and Bulgaria and Romania as well, continue to fall further behind. This unfavourable performance is shared with, among others, some of the Asian and Latin American countries included in our sample.

Clearly there is a lot of diversity in how countries perform. Although in each and every case there will be specific factors at work these will not be in focus here. Rather we will attempt, in a better way than in previous analyses, to single out some general factors that may be of interest when discussing the wide differences across countries in economic performance. These are, as noted,

– technology competitiveness,
– capacity competitiveness,
– cost competitiveness, and
– demand competitiveness.

Of these the two former are clearly multi-dimensional and therefore more difficult to handle. Our approach here will be to identify the most important dimensions, find reliable indicators, express these in a comparable format and weigh them together, giving each dimension an equal weight in the calculation of the composite indicator.[25] A complete list with definitions and sources for the indicators used is given in appendix. In some cases, missing data had to be estimated. Whenever possible, indicators are defined as activities measured in quantity or constant prices, deflated by population. To further increase comparability we normalize the indicators as follows:

$$(14) \qquad \frac{actual\,value - mean\ value}{standard\ deviation}$$

In the calculations the mean and standard deviation were fixed to that of the median year (1997). This means that changes over time in the volume of the activities measured by the individual indicators are allowed to spill over to the composite indicator (along with the changes caused by shifts in the position of countries on each individual indicator). For instance, in the early 1990s ICT diffusion was still at a relatively low level. Today ICT technologies are very widely used and are, arguably, of much higher importance to competitiveness than it was a decade ago. The way we calculate the capacity indicator is consistent with this.

Technology competitiveness

Technology (or technological) competitiveness refers to the ability to compete successfully in markets for new goods and services. Hence, this type of competitiveness is closely related to the innovativeness of a country. There is, however, no available data source which measures

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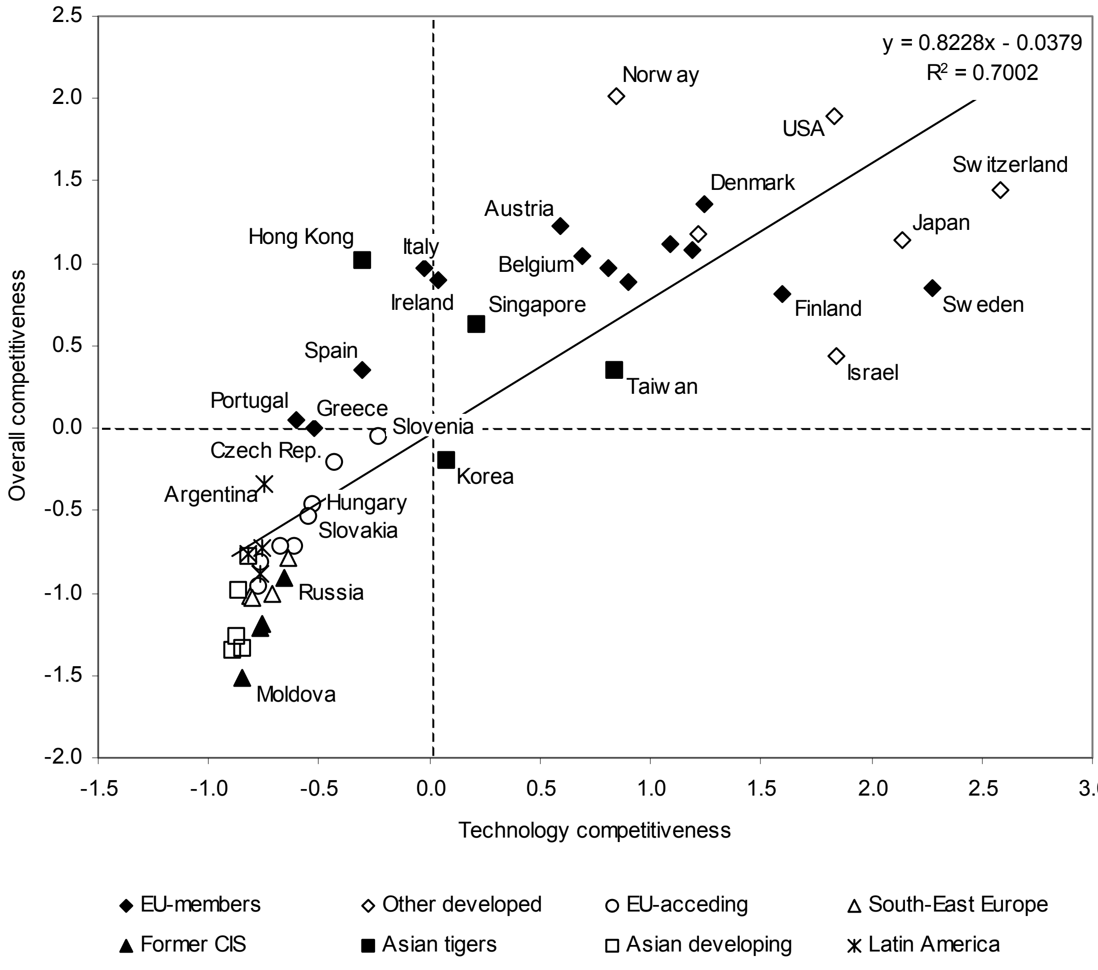
[25] Admittedly, there is an element of arbitrariness involved here. It would of course have been preferable to have prior knowledge about the "true weights" to use. Having no such information, we chose to give each variable an equal weight. Alternatively, one might have weighted variables based on the degree of correlation, based on the assumption that correlated variables express aspects of the same underlying phenomenon, in contrast to uncorrelated ones that are assumed to refer to different phenomena (as done in so-called "factor analysis", for instance). Correlation and causation are not the same, however. For instance, in our case ICT-use and corruption are highly correlated, without any obvious causal relationship. In contrast, our two measures of technology diffusion, investments and fees/payments for use of proprietary technology, are almost uncorrelated. For an extended discussion see European Commission, *State-of-the-art Report on Current Methodologies and Practices for Composite Indicator Development* (Ispra, European Commission Joint Research Centre (JRC), 2002), and M. Freudenberg, *Composite Indicators of Country Performance: A Critical Assessment* (Paris, OECD, STI Working Paper 2003/16).

innovativeness directly. Instead what we have are different data sources reflecting different aspects of the phenomenon. R&D expenditures, for instance, measure some (but not all) of the resources that go into developing new goods and services. Patent statistics, on the other hand, measure the output of (patentable) inventions. This is a very reliable indicator, but the propensity to patent varies considerably across industries, and many innovations are not patentable. So a lot of innovation would get unaccounted for by using this indicator only. Taking into account both indicators clearly gives a more balanced picture. To further increase the reliability of the composite indicator we also include a measure of the quality of the science base on which innovation activities depend as reflected in articles published in scientific and technical journals.

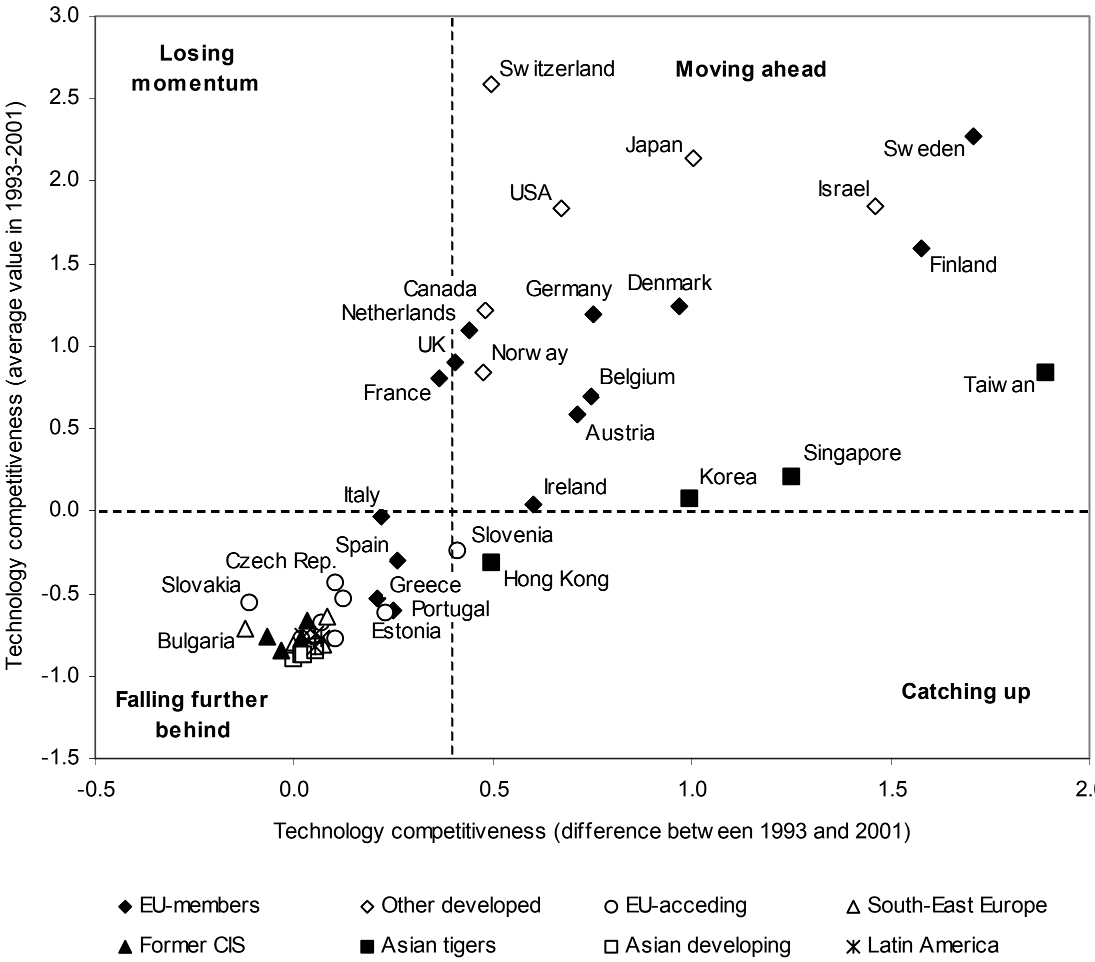
Figure 2: Overall and Technology Competitiveness (average levels 1993-2001)



Source: Own computations based on the World Bank (WDI), OECD (MSTI and Patent data), UNESCO and RICYT.

Figure 2 plots technology competitiveness on the horizontal axis against overall competitiveness, as reflected in GDP per capita, on the vertical axis. As is evident from the regression line there is a very close correlation between overall and technological competitiveness. The main deviants are some former centrally planned economies (headed by Moldova) and developing countries in Asia, all of which with GDP per capita levels much below what should be expected from their levels of technology competitiveness. But there are also some small advanced countries for which GDP per capita tend to lag behind technological competitiveness (Sweden and Israel in particular). On the other side of the spectrum, Norway and Hong Kong are examples of countries that have managed to arrive at relatively high levels of productivity and income without a similarly high technology competitiveness.

Figure 3: Technology Competitiveness



Source: Own computations based on the World Bank (WDI), OECD (MSTI and Patent data), UNESCO and RICYT.

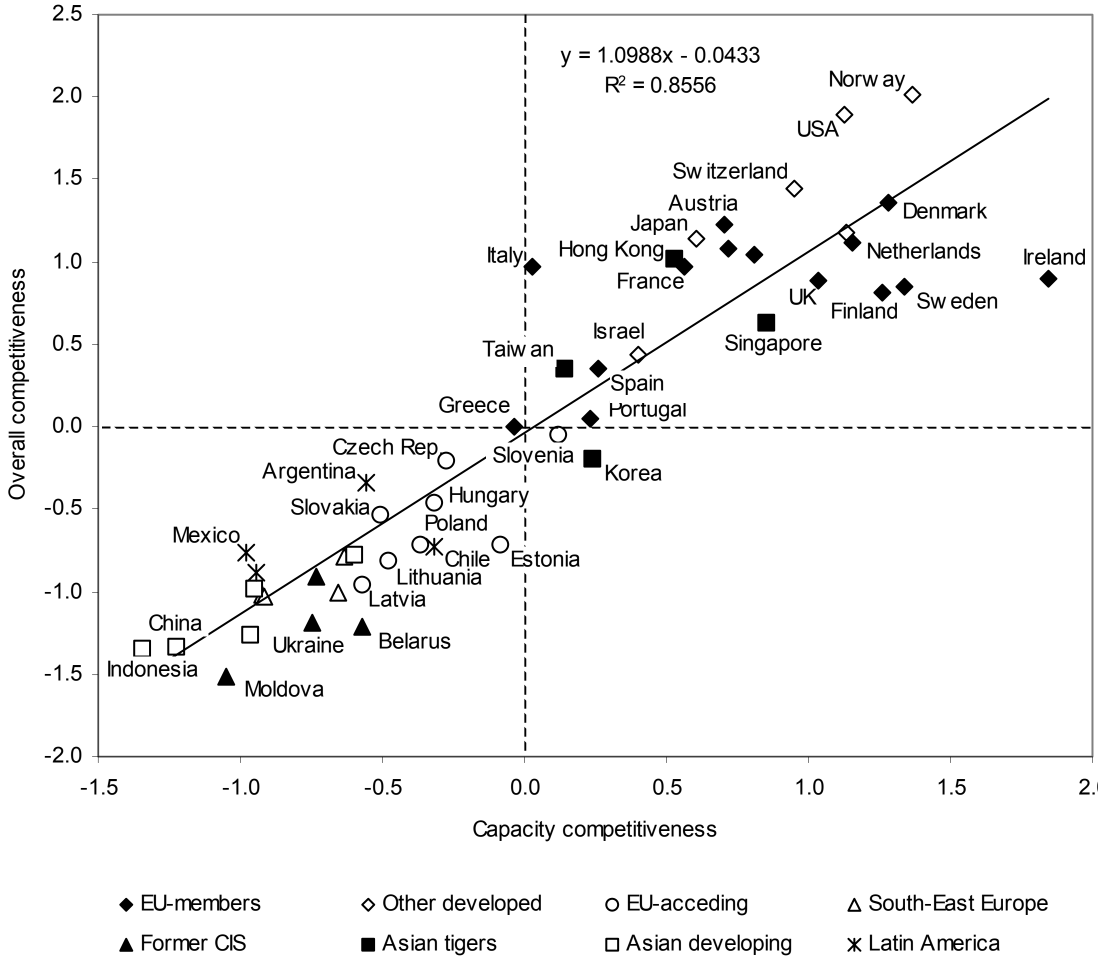
In figure 3 the level and trend in technology competitiveness is plotted against each other. When compared with the case of overall competitiveness in Figure 1, the indicator for technological competitiveness displays a much stronger tendency towards divergence. Countries either move ahead of the others or fall further behind, with only a few staying in the middle. Among the countries that move ahead technologically, Taiwan, Finland, Sweden and Israel are most prominent. Those falling further behind include the former centrally planned economies (except Slovenia) and the developing countries in Asia and Latin America.

Capacity Competitiveness

The distinction between technology competitiveness and capacity competitiveness is crucial. For instance, Sony did not develop the transistor, but showed a superior capacity to US firms when it came to exploiting this new technology in a way that sustained competitiveness. In fact, many of the inroads of Japanese producers on Western markets during most of the post-war period were of this kind. Although the distinction may be clear enough in theory, in practice it may not be all that simple, since resources that are devoted to developing new goods and services may also be beneficial for the ability to exploit such innovations economically and vice versa.[26] Nevertheless, we will focus on four dimensions of capacity competitiveness, as distinct from technology competitiveness. These four dimensions are human capital, ICT infrastructure, diffusion and social and institutional aspects. The importance of a well-developed human capital base for exploiting technological opportunities goes without saying; here we focus on secondary and tertiary education (as reflected in enrolment rates) in particular. Similarly, a well-developed ICT infrastructure is generally acknowledged as a must, we measure this with the help of data on the spread of computers and telecommunication technologies across the population. However, the importance of diffusion – or the ability to quickly put new technologies into use - extends beyond that of ICT. We take this into account in two ways, as embodied in investments and disembodied through payments of royalty or license fees. Finally, we acknowledge that there may be a number of social and institutional factors of importance for the capacity to exploit technological opportunity. Although such factors often defy measurement, at least on a broad cross-country/cross-temporal basis, there exist survey-data on the incidence of corruption across countries, which is relevant to consider.

[26] W. Cohen, and D. Levinthal, "Absorptive Capacity: A New Perspective on Learning and Innovation", *Administrative Science Quarterly*, Vol. 35, 1990, pp. 128-152.

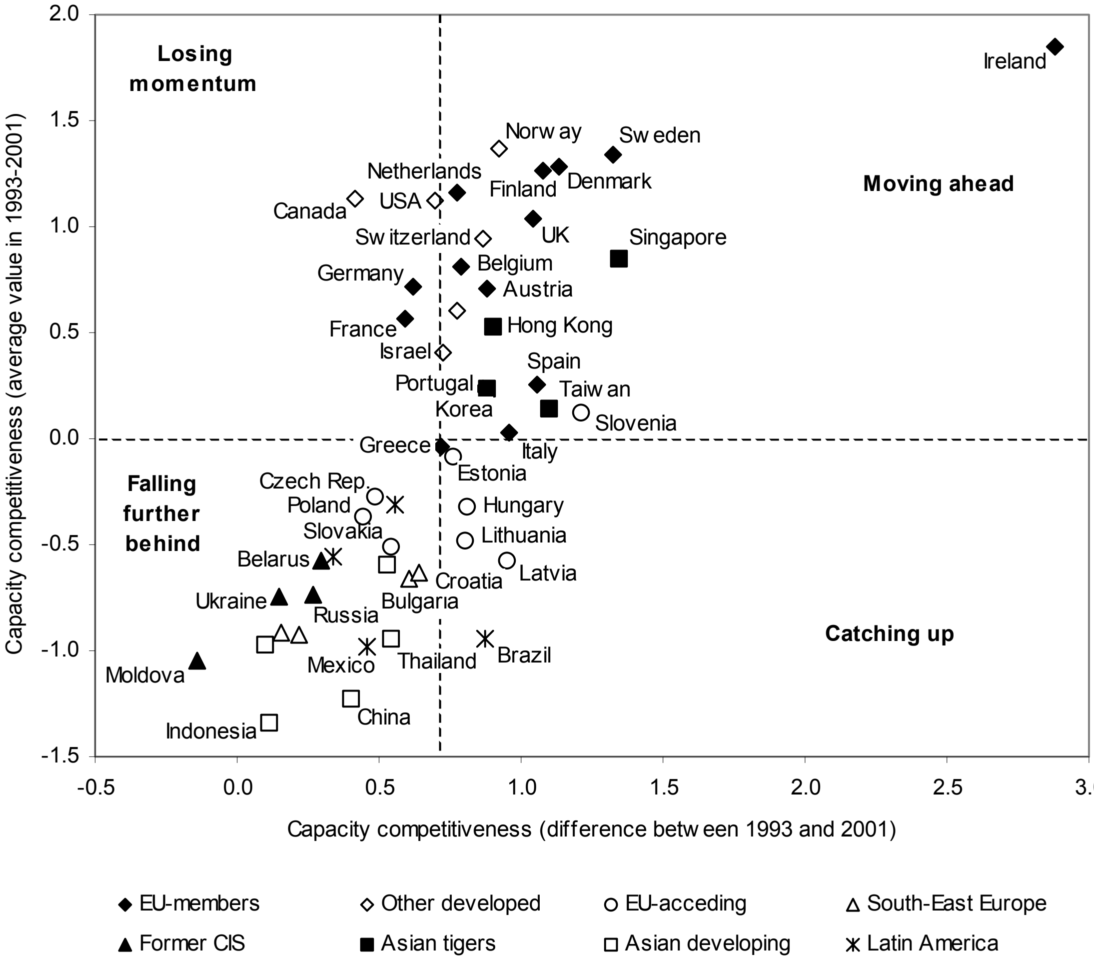
Figure 4: Overall and Capacity Competitiveness (average levels 1993-2001)



Source: Own computations based on the World Bank (WDI), UNESCO, USAID (Global Education Database), ITU (World Telecommunication Indicators) and Transparency International (Corruption Perception Index).

Figure 4 plots our estimate of capacity competitiveness (horizontal axis) against overall competitiveness as reflected in GDP per capita (vertical axis). As with technology competitiveness there is a very clear, positive relationship between capacity competitiveness and GDP per capita. The fit is even better than in the previous case, 86 per cent of the differences in GDP per capita across countries can be explained by differences in the capacity to exploit technological opportunity (against 70 per cent for technology competitiveness). Consistent with this close fit there are few obvious deviants, with the possible exception of Ireland, which reports a much higher capacity for exploiting technology than indicated by its GDP per capita.

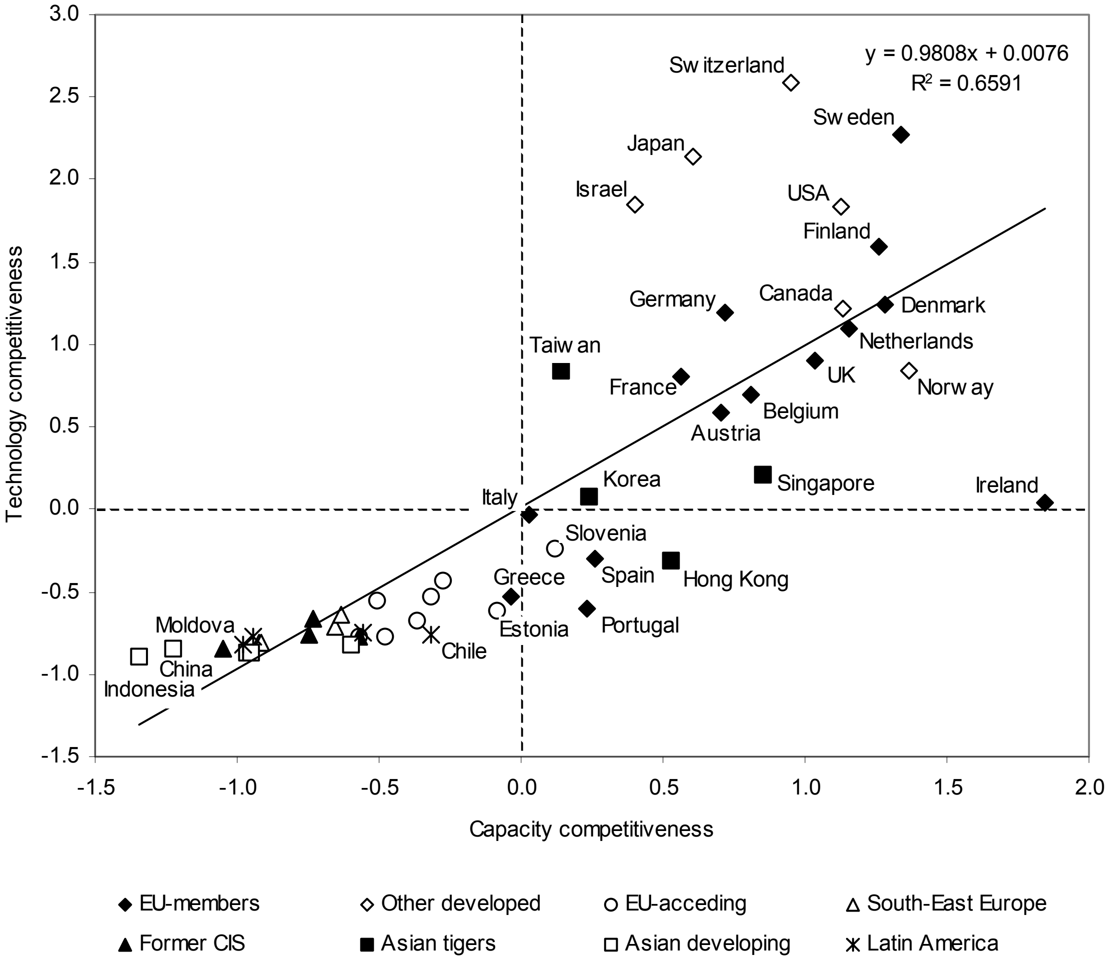
Figure 5: Capacity Competitiveness



Source: Own computations based on the World Bank (WDI), UNESCO, USAID (Global Education Database), ITU (World Telecommunication Indicators) and Transparency International (Corruption Perception Index).

Figure 5, which plots the level and trend of capacity competitiveness against each other, confirms the peculiar Irish pattern, with a very high and growing level of capacity for exploiting new technology. Hence, Ireland appears to an example of a country that has, with considerable success, focused mainly at developing capacity competitiveness at the possible expense of technological competitiveness. This contrasts with position of a number of other economies, such as Switzerland, Israel and Japan, which - although technologically advanced - appear to have less well developed capabilities for exploiting these advantages commercially (Figure 6).While technological competitiveness displays strong signs of divergence, there is more convergence going on in the capacity to exploit technological opportunity. The Baltics in particular, appear to catch up in capacity competitiveness, while some of the most advanced economies have very slow capacity growth. However, there are also diverging trends at work, with a number of the formerly centrally planned economies reporting below average capacity growth, and the same holds for most of the developing Asian and Latin American countries included in our sample.

Figure 6: Technology and Capacity Competitiveness (average levels 1993-2001)

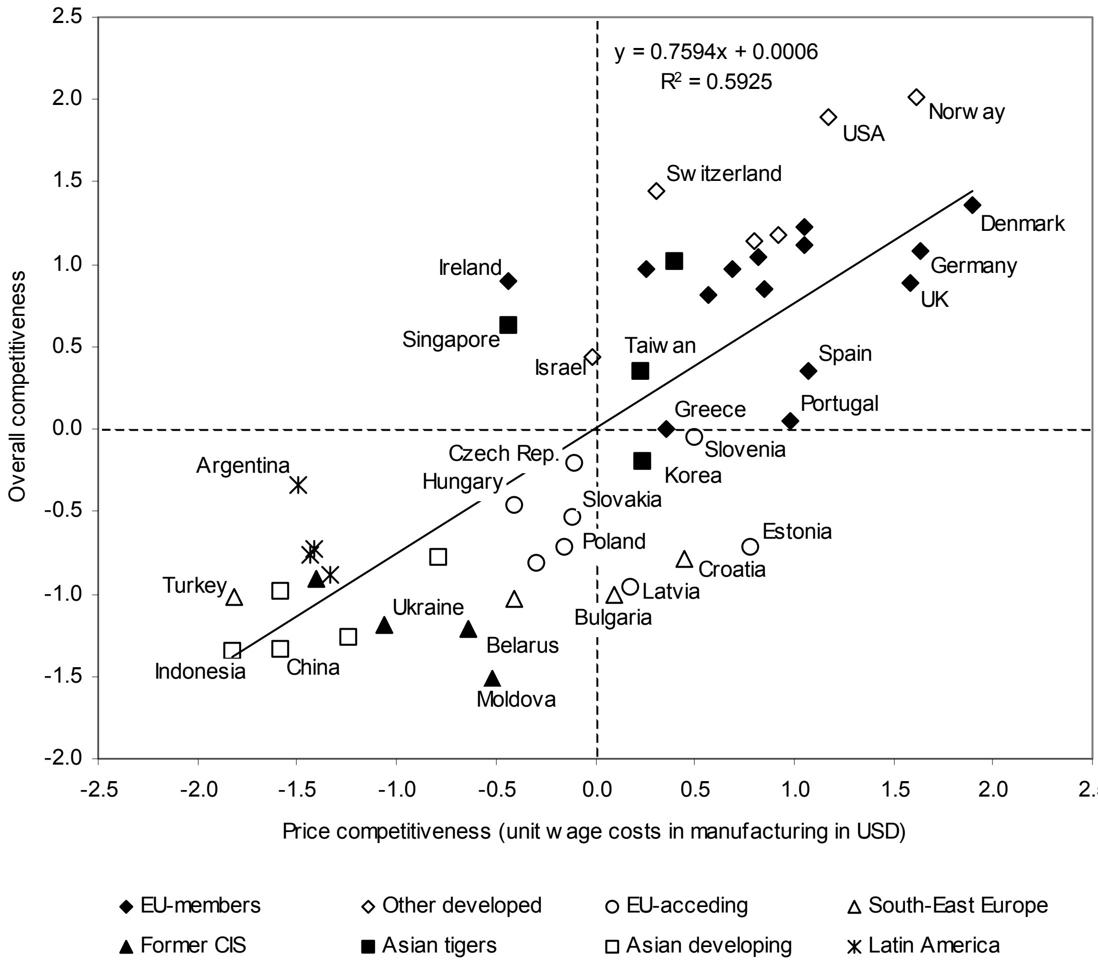


Source: Own computations based on the World Bank (WDI), OECD (MSTI and Patent data), UNESCO, USAID (Global Education Database), ITU (World Telecommunication Indicators), Transparency International (Corruption Perception Index), and RICYT.

Price competitiveness

In one sense price- or cost competitiveness should be the easiest dimension to identify. In fact, for a long time economists focused only on price or cost competitiveness, and a well defined indicator – unit labour costs in manufacturing in a common currency – was readily available. We, however, found that indicator to be one of the most problematic in terms of data coverage. The estimates of price or cost competitiveness (unit wage costs in manufacturing) presented here are based on several sources and considerable judgement had to be made in order to improve the coverage (see the appendix for further details). Among other things indirect wage costs (benefits etc.) could not be taken into account due to lacking data for many countries. Hence the estimates presented should be interpreted with considerable care.

Figure 7: Overall and Price Competitiveness (average levels 1993-2001)

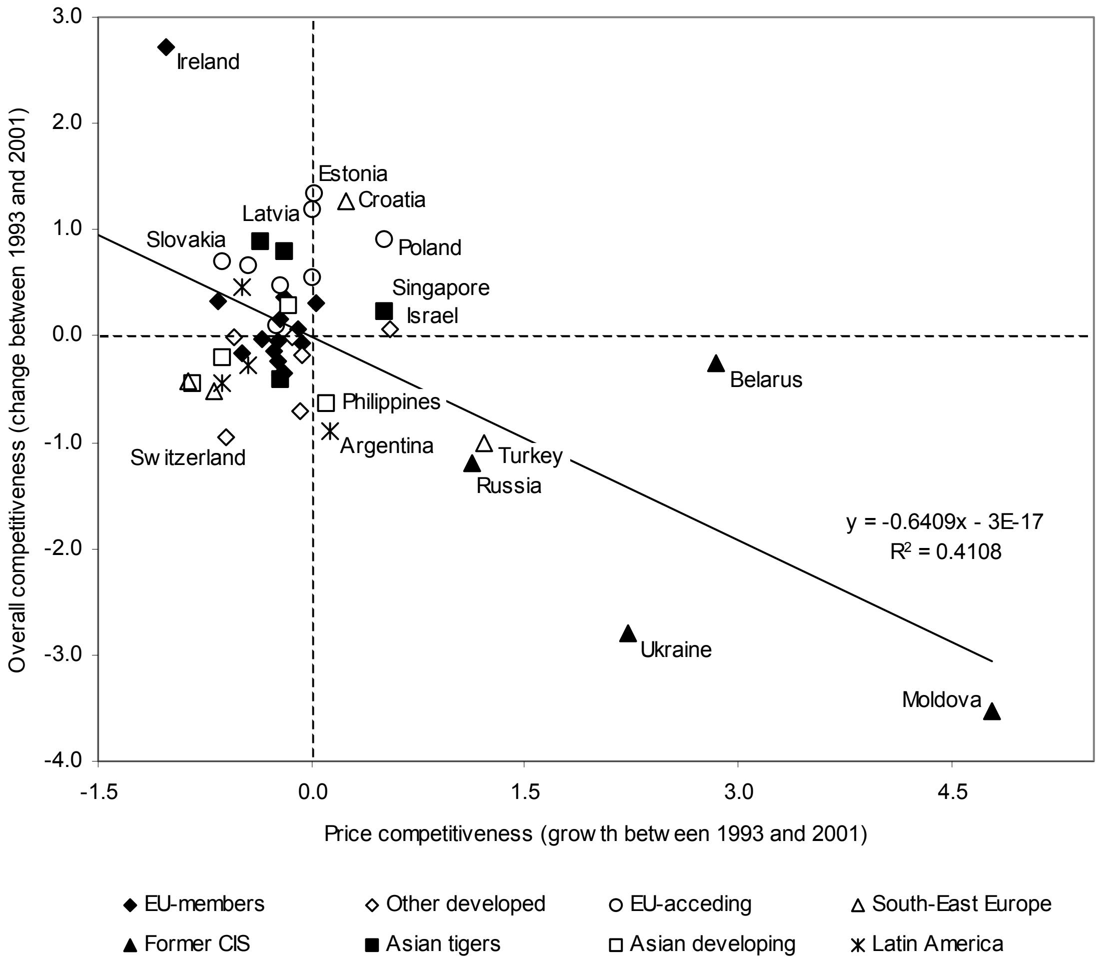


Source: Own computations based on the World Bank (WDI), OECD (STAN Database), ILO (LABORSTA Database), Eurostat (AMECO) and WIIW (WIIW Industrial Database Eastern Europe).

Figure 7 plots price competitiveness, measured as unit wage costs in manufacturing (horizontal axis) against overall competitiveness, measured through GDP per capita (vertical axis). As is evident from the figure there generally is a positive relationship as should be expected; more advanced (richer) economies, using highly qualified labour, generally pay higher wages per unit produced than do less developed, poorer countries. There is, however, considerable variation around the regression line. For instance, some developed economies, such as Ireland, Switzerland, USA and Norway, consistently have higher productivity levels than indicated by their price or cost competitiveness, while for some formerly centrally planned economies the situation is the other way around.[27]

[27] This may reflect differences in exchange-rates. While GDP per capita is measured in PPPs, wages are measured in current exchange-rates, which in several countries have been regulated to encourage exports and attract inflows of foreign capital.

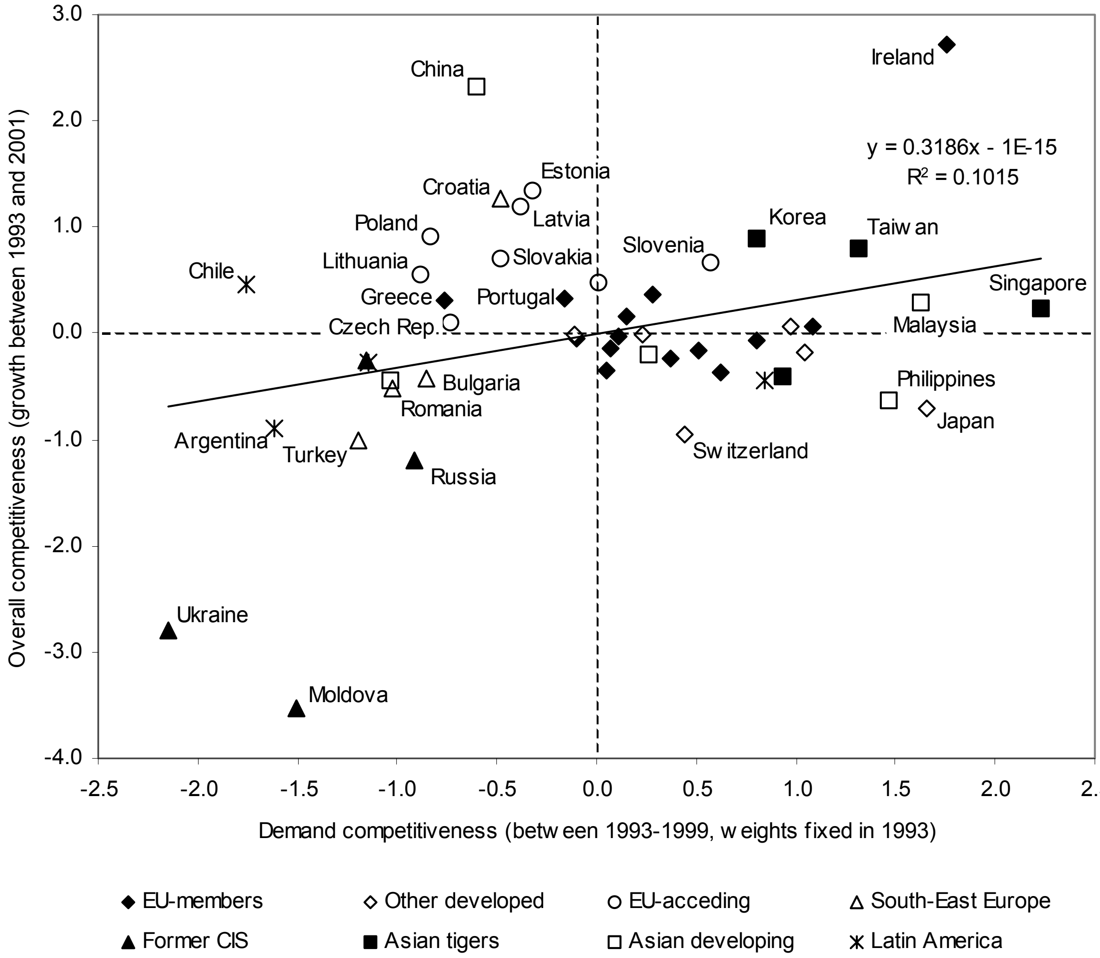
Figure 8: Overall and Price Competitiveness (change between 1993 and 2001)



Source: Own computations based on the World Bank (WDI), OECD (STAN Database), ILO (LABORSTA Database), Eurostat (AMECO) and WIIW (WIIW Industrial Database Eastern Europe).

The rate of change in price or cost competitiveness is usually considered as more important than the absolute level. Figure 8 plots the growth of price competitiveness (unit wage costs in manufacturing in common currency) on the horizontal axis against growth of overall competitiveness (GDP per capita) on the vertical. The regression line has the usual negative slope, which means that on average the higher the growth of price competitiveness, the lower the rate of growth, and vice versa. This, obviously, concurs with the traditional view on competitiveness, which focuses mainly on the damaging effects on the economy of excessive wage growth. Note, however, that the estimated relationship depends to some extent on outliers (Moldova, Belarus, Ukraine and Ireland). If these observations are excluded, the regression line becomes much flatter, and the estimated coefficient no longer significant.

Figure 9: Overall and Demand Competitiveness



Source: Own computations based on the World Bank (WDI) and UN Comtrade Database.

Demand competitiveness

The relationship between a country production (or trade) structure and the composition of world demand may also be of importance for competitiveness. Better the match, the more favourable the country's economy should be supposed to develop, and vice versa. We capture this aspect by weighting the growth of world demand (by commodity) by the commodity composition of each country's exports:

$$\sum_{i=1}^{n} w_{ij} g_{iT} \qquad (15)$$

where w is share of product group in country j, g is growth of the export market, i is product group and T is market total.

Figure 9 plots the relationship between demand competitiveness, so defined (horizontal axis), and growth of GDP per capita (vertical axis). It is evident from the regression included in the figure that there is a positive albeit weak relationship between the two variables. Those that appear to have gained most from the composition of demand were Ireland and some

Asian economies, while some former centrally planned economies, joined by Chile and Argentina, were the least favourably affected.

3. The dynamics of the competitiveness of the countries of the ECE region

Having developed empirical indicators of the different aspects of competitiveness, we will apply these indicators in an analysis of the differing performance of ECE countries. However, the short time period for which (reliable) data are available (especially for many of the former centrally planned economies) puts severe limits on the possibilities for econometric work. We therefore refrained from estimating the entire model, and chose instead to concentrate on its reduced form, as given by equation 13', according to which the rate of economic growth of a country should be a weighted sum of

- the potential for diffusion,
- growth in technological competitiveness,
- growth in capacity competitiveness,
- growth in cost competitiveness, and
- demand competitiveness, all relative to that of other countries.

The main purpose of the estimation, then, is to estimate these weights, which in turn will be used to assess the impact of the different aspects of competitiveness on economic growth. To calculate the potential for diffusion we use, as in previous empirical applications of this model, the difference between the level of GDP per capita in the country and average GDP in our sample, deflated by the GDP per capita in the leader country. For the other four variables we used the indicators developed in the previous section.

However, the normalization procedure used in creating the indicators of technology and capacity competitiveness made it difficult to calculate growth rates. We therefore transformed the normalized indicators to a series of positive numbers (by adding a sufficiently high positive number) before calculating the growth rates.[28]

Table 1 presents the results of the regression analysis. The coefficients for the five variables included in the model all have the expected signs, significantly different from zero at the 1 per cent or 10 per cent level. The explanatory value is high, above 70 per cent. Since the period of estimation was characterized by severe problems for some country groupings (the "Asian crisis" for instance), we also test for the possible impact of this by including dummy variables for relevant country groupings. As is evident from the table none of these

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[28] Assume a variable A with a constant mean m and a constant standard-deviation s, then the normalized indicator i of A is $i = (A-m)/s$. We then define a variable $I = i + n$ which we substitute into the expression for i. Differentiating with respect to time and rearranging we get the following expression for the growth rate of I:

$dI/I = dA/(A+s(n-m/s))$.

As is easily verifiable, the actual and transformed variable grow at the same rate if $n = m/s$. Since this ratio is unknown, we used the means of similar ratios for the variables included in the calculation of the composite indicators. As a result, in calculating the growth technology competitiveness indicator, n was set to 1.0 and for capacity competitiveness to 2.0. However, it turned out that the two series became highly correlated, giving rise to multicollinearity. In an attempt to reduce this problem, we transformed the scale of capacity growth indicator by adding 10.0 instead of 2.0 (before calculating the growth of this indicator).

dummies were significant at conventional levels of significance, and the impact on the estimates for the other variables was small, although the significance of the estimated coefficients declined in a few cases (particularly for the demand variable).

Table 1. Results of OLS regression.

	(1)	*(2)*	*(3)*	*(4)*	*(5)*
Intercept	0.000 (0.000)	0.044 (0.208)	0.070 (0.341)	–0.069 (–0.309)	–0.003 (–0.012)
Gap	–0.031 (–3.561)***	–0.031 (–3.556)***	–0.033 (–3.759)***	-0.029 (–3.208)***	–0.031 (–3.144)***
Technology	0.202 (2.755)***	0.196 (2.652)***	0.178 (2.359)**	0.205 (2.779)***	0.201 (2.433)**
Capacity	1.077 (1.931)*	1.104 (1.962)*	1.104 (1.991)**	0.983 (1.708)*	1.083 (1.758)*
Price	–0.567 (–5.572)***	–0.531 (–4.624)***	–0.595 (–5.749)***	–0.562 (–5.474)***	–0.566 (–5.325)***
Demand	0.425 (1.716)*	0.400 (1.588)	0.422 (1.719)*	0.444 (1.772)*	0.422 (1.578)
Dummy for CIS Countries		–0.716 (–0.700)			
Dummy for Balkan Countries			–1.150 (–1.260)		
Dummy for Acceding Countries				0.422 (0.717)	
Dummy for Asian Countries					0.017 (0.024)
R^2	0.708	0.712	0.719	0.712	0.708
Adjusted R^2	0.674	0.670	0.679	0.671	0.667
F-test	20.875	17.272	17.899	17.286	16.992
Observations	49	49	49	49	49

Note: t-statistics in parentheses. *, **, *** denote significance at the 10, 5 and 1 percent levels (two-tailed tests).

To illustrate the implications of these estimates, we decomposed the estimated growth of GDP (relative to the average of the sample) for eight different country groups into its constituent parts (as explained by the estimated model and the relevant data). Table 2 ranks the eight country groups after their initial GDP per capita, from highest to lowest. As is evident from the table, the model captures most of the qualitative features, although the explanatory power is not perfect, especially not for some of the richest countries in our sample (the so-called "other developed" countries). The model predicts that these rich countries should be expected to grow relatively slowly (as they on average do), mainly as a consequence of the lacking diffusion potential and the failure to increase technology and capacity competitiveness sufficiently to make up for this loss. However, the model fails to replicate "the new economy boom" that some of these countries went through in the 1990s, and hence underestimates their average growth during this period. The prediction is better for the EU countries (which also benefit less than many others from the potential for diffusion). However, on average, for the EU countries this is more than counteracted by other factors.[29] The prediction is also reasonable for the Asian "tigers", whose relatively rapid growth

Table 2. Actual and estimated differences in growth vis-à-vis the world average, 1993-2001.

Region	GDP per capita in 1993	Actual difference in growth	Estimated difference in growth	Explanatory factors				
				Gap	Tech-nology	Capacity	Price	Demand
Other developed	22,270	-0.2	-0.8	-1.2	-0.1	0.0	0.2	0.3
EU-members	17,826	0.3	0.5	-0.7	0.3	0.3	0.4	0.2
Asian Tigers	14,632	2.0	2.4	-0.3	1.6	0.4	0.1	0.6
EU-acceding	7,621	0.8	0.5	0.5	-0.1	0.1	0.2	-0.2
Latin America	7,276	0.1	0.2	0.6	-0.2	-0.1	0.4	-0.5
South-East Europe	5,180	-1.1	-0.6	0.8	-0.6	-0.4	0.0	-0.4
Former CIS	4,633	-5.4	-5.0	0.9	-1.0	-0.7	-3.4	-0.7
Asian Developing	3,709	1.7	1.2	1.0	-0.3	-0.4	0.8	0.2

Source: Own calculations. Data for GDP (in PPPs current international $) from WDI.

[29] Note that the smaller EU member countries, which in many cases improved their technology and capacity competitiveness during this period, as defined here, dominate the EU average. Some of the larger EU countries had a much bleaker performance, however, particularly France and Germany.

is mainly accounted for by growing technological competitiveness. This contrasts with the performance of the poorer country groupings, all of which suffer from deteriorating technology competitiveness (relative to the sample average) and, with the exception of the new EU members, deteriorating capacity competitiveness as well. The poorer economies are also, with one exception (the developing countries in Asia) hampered by a very unfavorable match between production structure and external demand (which tend to favors the Asian tigers and other advanced economies). These negative factors are especially significant for the former CIS countries, whose negative performance is greatly compounded by very rapidly increasing wage costs per produced unit relative to other countries.

4. *Conclusions*

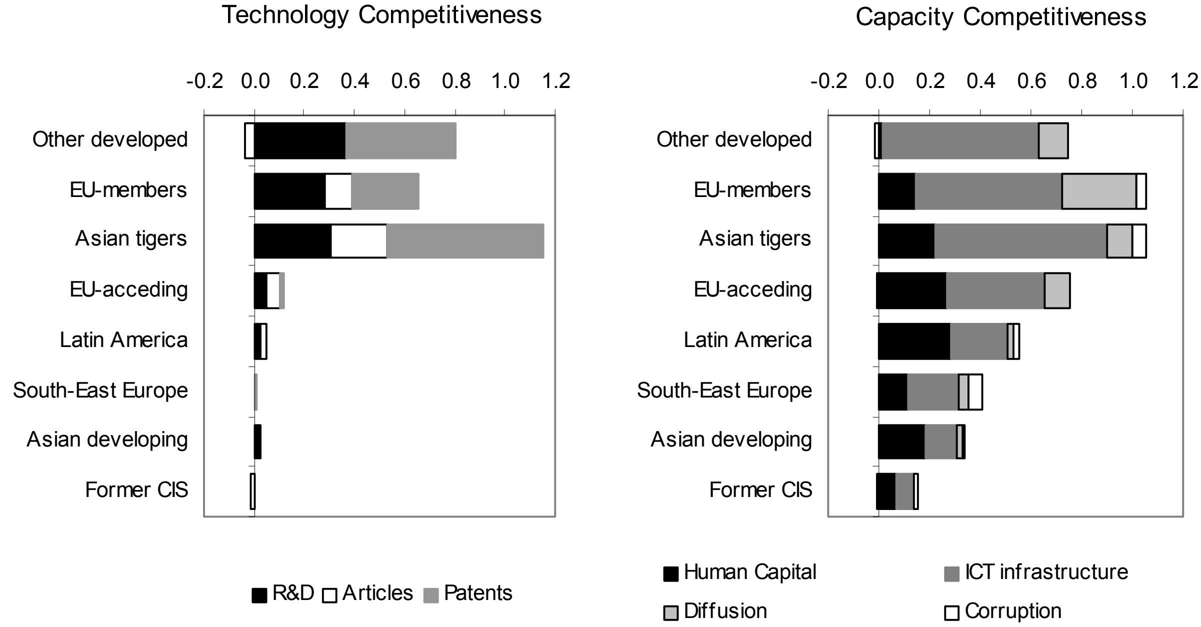
The purpose of this paper has been to empirically scrutinize why some countries, with particular emphasis on the ECE region, consistently outperform others. Our search was guided by a theoretical perspective that places emphasis on the role played by four different aspects of competitiveness; technology, capacity, costs and demand. The contribution of the paper is particularly to highlight the two first aspects, which often tend to get lost because of measurement problems.

Our empirical analysis, based on a sample of 49 countries between 1993 and 2001, demonstrated the relevance of both technology and capacity competitiveness. The former is the main explanation behind the continuing good growth performance of the "Asian tigers" relative to other major country groups. Deteriorating capacity competitiveness, on the other hand, is one of the main factors hampering low-income countries in Europe (the formerly centrally planned economies in particular) and Asia in exploiting the potential for catch-up in technology and income.

What are the crucial factors behind these developments, and what can governments do in order to improve the relative position of their economies? To better deal with these questions we illustrate in figure 10 the factors behind the observed changes over time in technology and capacity competitiveness.

The differences across country groups are striking. As for technology competitiveness, there is a clear divide between the advanced countries, with healthy and continuing increases, and the rest of the world, which, with a partial exception for the new EU members, are stagnant at best. The "Asian tigers" stand out with the best performance. This difference (relative to other developed countries) is not so much rooted in increases in R&D as in growing innovation (measured by patents) and the development of the scientific infrastructure. A divide of a different sort is clearly visible along the capacity dimension. In this case there actually is some catch up along one dimension, human capital, particularly by the new EU members, and the developing countries in Asia and Latin-America. This, however, is more than counteracted by an increasing digital divide (ICT-infrastructure), caused by much higher investments in ICT in the already developed economies and among the Asian Tigers than elsewhere.

Figure 10: Contribution to Change of Technology and Capacity Competitiveness



Source: Own computations based on the World Bank (WDI, edition 2003), OECD (MSTI and Patent data), UNESCO, USAID (Global Education Database), ITU (World Telecommunication Indicators), Transparency International (Corruption Perception Index), and RICYT.

These trends point to the possibility of continuing divergence in the world economy, as emphasized also by other recent studies.[30] However, at any time some countries manage to defy the trend, as the "Asian tigers" indeed have done in latter half of the post second-world-war period (and Japan before them). In our sample it is the group of former centrally planned economies countries that are about to join the European Union that appear to have the best chance in that respect. These favourable prospects contrast with those of a number of other former centrally planned economies, which appear to witness deteriorating competitiveness along all our four dimensions. Clearly, if these countries are ever going to catch up, they will have to find ways to break this vicious circle. Some of the developing countries in Asia are growing fast but this growth has to large extent been based on exploiting the diffusion potential through a low cost strategy. There is danger that some of these countries may soon find themselves constrained by lagging technology and capacity competitiveness (unless appropriate action is taken).

[30] See, for example, J. Fagerberg, and B. Verspagen, "Technology-Gaps, Innovation-Diffusion and Transformation: An Evolutionary Interpretation", *Research Policy*, Vol. 31, 2002, pp. 1291-1304.

Appendix on Data and Sources

The main sources of data include World Development Indicators (WDI) from the World Bank; OECD Main Science and Technology Indicators (MSTI), Patent Database and STAN database; UNCTAD Handbook of Statistics; UNESCO Institute for Statistics; ILO LABORSTA database; World Telecommunication Indicators from the International Telecommunication Union (ITU); UN Comtrade Database and Corruption Perception Index conducted by Transparency International. The remaining gaps were filled from the Eurostat's New Cronos and AMECO (Annual macro-economic database); Science & Technology Ibero-American Indicators Network (RICYT) and Global Education Database collected by USAID. National sources were used if necessary only for Taiwan and in a few cases also for R&D data from the other Asian countries.

The selection of sub-components for composite indicators of technology and capacity competitiveness is based on the theoretical framework, but it is also influenced by the availability of internationally comparable data for a broad range of countries (see Table A1). We measure technology competitiveness by three indicators: R&D expenditures (Gross Domestic Expenditure on R&D – GERD), patenting activity (USPTO patent grants) and number of scientific and technical journal articles (based on the Institute of Scientific Information's Science and Social Science Citation Indexes). We focus on four dimensions of capacity competitiveness, namely human capital, ICT infrastructure, technology diffusion and broader social or institutional context represented by corruption. In the construction of the composite indicator of capacity competitiveness we applied a two-stage approach using sub-indices of the individual indicators that capture the same dimension. The two-step approach avoids underestimating influence of those aspects for which fewer indicators are available.

Special care has to be taken for US patenting performance to suppress the "home country advantage" since the propensity of American residents to register inventions in their own national patent office is higher than that of non-residents. We adjusted the US performance in its home base downwards based on a comparison between the Japanese and the US patents registered at the European Patent Office (EPO), which represents a foreign institution both for Japanese and American inventors. We used an estimation proposed by Archibugi and Coco:[31]

$$\textit{Adjusted US patents at the USPTO} = (JAP_{USA} * USA_{EPO})/ JAP_{EPO}$$

where JAP_{USA} represents patents granted to Japanese residents in the USA, while USA_{EPO} and JAP_{EPO} capture patents granted to Japanese and American residents at the EPO.

Although the selected indicators have broad coverage compared to alternative measures, in some cases there were missing values that had to be dealt with. Depending on the source of the problem we used a linear trend between the nearest neighbours, extrapolated the time series with average annual growth over the available period or used group mean substitution to fill in the missing data points. Out of the total of 3969 observations (9 indicators, 49 countries and 9 years –Corruption Perception Index excluded - see below), nearest neighbour substitution was used only for 81 observations (mainly for R&D and education data) and

[31] D. Archibugi, and A. Coco, "A New Indicator of Technological Capabilities for Developed and Developing Countries (ArCo)", *World Development*, Vol. 32, 2003, pp. 567-724.

extrapolation for 354 observations (more than two thirds of the latter was due to missing data for the scientific and technical journal articles in 2000-2001 and for secondary and tertiary enrollment in 2001). The coverage of educational data was particularly weak in the recent years (in all WDI, UNESCO and USAID databases) due to a recent change of methodology (change from ISCED 76 to ISCED 97). The entire time series were missing in six cases, mainly for the royalty and license fees payments series (for Denmark, Switzerland, Singapore, Taiwan and Indonesia) and for personal computers (Belarus). We used group mean substitution to fill in these gaps using averages for the EU, Asian Tigers, other Asian and former CIS countries.

Table A1: Composite Indicators of Technology and Capacity Competitiveness

Dimension	*Sub-component*	*Indicator*	*Scaling*	*Source*
Composite Indicator of Technology Competitiveness:				
S&T inputs	R&D expenditure	GERD	per capita	WDI, MSTI, RICYT, national sources
S&T outputs	Scientific publications	Scientific and technical journal articles	per capita	WDI (based on ISI)
	Patenting activity	USPTO patent grants (inventor's residence country)	per capita	OECD Patent database
Composite Indicator of Capacity Competitiveness:				
Human capital	Tertiary education	Tertiary School enrolment	% gross	WDI, UNESCO, USAID
	Secondary education	Secondary School enrolment	% gross	WDI, UNESCO, USAID
ICT infrastructure	Computers	Personal computers	per capita	WDI, ITU
	Telecommunication	Fixed line and mobile phone subscribers	per capita	WDI, ITU
Diffusion	Embodied technology	Gross fixed capital formation	per capita	WDI
	Disembodied technology	Royalty and license fees: payments	per capita	WDI
Social aspect	Corruption	Corruption Perception Index	index	Transparency International

Special treatment was needed for Corruption Perception Index series as Transparency International publishes this measure only from 1995 onwards and data for most of the former centrally planned economies are reported only for the period 1998-2003. This indicator is the only measure in our composites based on qualitative “soft” data collected by opinion surveys. By nature such a measure partly depends on subjective opinions of the respondents, which in strict sense raises questions about its comparability over time. However, the level of corruption in the economy tends to be rather stable over time in most countries (the mean went down from 6.12 to 5.65 between 1995 and 2003). Hence, we decided to smooth the available series with a linear trend, replace the actual figures with the estimates and extrapolate the missing values at the beginning of the period. This method is robust as the correlation coefficient between the actual and fitted values is 0.9889 for the period 1998-2003.

We used unit wage costs in manufacturing expressed in common currency (US dollars) as a measure of price or cost competitiveness (1993-2001, except for Moldova (1994-2001)). This indicator was depending on data availability defined either as the ratio of total wages to value added or as monthly wages of employees divided by value added per worker. The OECD STAN database and Eurostat AMECO database were used as the main sources of value added, employment and wages for its member and candidate countries, while the WDI and ILO LABORSTA databases were used for the remaining countries.

The indicator for demand competitiveness was calculated using data from the UN COMTRADE database at the 3-digit level (SITC Rev.3) over the period 1993-1999.

Table A2: Indicators of Competitiveness

Country	Composite indicators				Unit wage costs in manufacturing (in USD)		Demand competitiveness (annual average in %)
	Technology competitiveness		Capacity competitiveness		Price competitiveness		
	1993	2001	1993	2001	1993	2001	1993-1999
Argentina	-0.78	-0.72	-0.71	-0.37	10.1	11.3	4.6
Austria	0.28	0.99	0.33	1.21	57.1	44.7	7.0
Belarus	-0.78	-0.76	-0.70	-0.40	9.7	32.3	5.1
Belgium	0.34	1.08	0.45	1.24	50.9	46.7	6.6
Brazil	-0.79	-0.73	-1.31	-0.44	11.9	10.4	5.1
Bulgaria	-0.62	-0.74	-0.94	-0.34	46.3	28.3	5.5
Canada	1.02	1.50	0.94	1.36	55.9	41.8	6.7
Chile	-0.76	-0.74	-0.55	0.00	12.7	10.9	4.4
China	-0.87	-0.81	-1.41	-1.01	14.2	7.2	5.8
Croatia	-0.67	-0.59	-0.91	-0.27	30.8	38.8	5.9
Czech Rep.	-0.48	-0.37	-0.44	0.05	35.0	32.9	5.6
Denmark	0.80	1.77	0.75	1.89	66.3	61.9	6.4
Estonia	-0.71	-0.49	-0.47	0.29	38.9	43.0	6.1
Finland	0.85	2.43	0.75	1.82	44.9	43.5	6.8
France	0.66	1.02	0.33	0.92	47.0	44.0	6.9
Germany	0.91	1.66	0.47	1.09	62.8	58.9	7.2
Greece	-0.62	-0.41	-0.28	0.44	36.3	40.4	5.6
Hong Kong	-0.54	-0.05	0.07	0.97	40.9	38.8	7.5
Hungary	-0.55	-0.42	-0.67	0.14	32.0	30.3	6.5
Indonesia	-0.89	-0.89	-1.40	-1.29	7.9	6.1	5.3
Ireland	-0.24	0.36	0.62	3.49	36.7	20.8	8.4
Israel	1.29	2.76	0.06	0.78	26.0	38.8	7.5
Italy	-0.12	0.11	-0.39	0.57	39.3	38.1	6.5
Japan	1.72	2.73	0.23	1.00	46.2	48.2	8.3
Korea	-0.40	0.59	-0.20	0.68	40.6	35.0	7.4
Latvia	-0.78	-0.76	-0.95	0.00	33.5	36.6	6.0
Lithuania	-0.81	-0.71	-0.83	-0.03	23.6	25.6	5.4
Malaysia	-0.84	-0.79	-0.82	-0.29	21.8	21.5	8.2
Mexico	-0.85	-0.80	-1.18	-0.72	16.0	12.6	7.4
Moldova	-0.83	-0.86	-0.96	-1.10	7.7	28.3	4.7
Netherlands	0.87	1.31	0.85	1.62	56.0	48.5	6.6
Norway	0.61	1.09	0.90	1.82	59.7	60.0	6.3
Philippines	-0.88	-0.86	-1.01	-0.91	14.4	16.1	8.1
Poland	-0.71	-0.64	-0.55	-0.11	24.9	36.1	5.5
Portugal	-0.70	-0.45	-0.16	0.71	67.1	45.8	6.3
Romania	-0.80	-0.81	-0.96	-0.81	33.6	24.0	5.3
Russia	-0.66	-0.63	-0.81	-0.54	7.0	10.9	5.4
Singapore	-0.28	0.97	0.19	1.54	20.8	29.4	8.9
Slovakia	-0.49	-0.60	-0.73	-0.20	39.3	28.6	5.9
Slovenia	-0.40	0.01	-0.39	0.82	47.5	38.7	7.1
Spain	-0.41	-0.16	-0.21	0.85	55.6	52.3	6.6
Sweden	1.57	3.28	0.69	2.02	48.9	51.4	7.4
Switzerland	2.39	2.89	0.58	1.44	47.9	35.1	7.0
Taiwan	0.06	1.95	-0.32	0.78	38.3	37.1	7.9
Thailand	-0.88	-0.85	-1.19	-0.65	10.1	8.2	6.8
Turkey	-0.84	-0.76	-1.01	-0.79	6.0	9.3	5.1
Ukraine	-0.71	-0.78	-0.79	-0.64	8.8	21.9	3.9
U.K.	0.73	1.13	0.57	1.61	61.7	63.9	7.7
U.S.A.	1.59	2.27	0.81	1.50	52.6	55.5	7.6

Note: In the regression analysis we used differences between the annual growth rate of the indicator for each country and the sample average as defined in the equation (13'). Source: Own computations based on the World Bank (WDI), OECD (MSTI, STAN and Patent database), UNESCO, USAID (Global Education Database), ITU (World Telecommunication Indicators), Transparency International (Corruption Perception Index), RICYT, ILO (LABORSTA Database), Eurostat (AMECO) and UN Comtrade Database.

Table A3: Contribution of Sub-components to the Composite Indicators

Country	Technology Competitiveness						Capacity Competitiveness							
	Contribution to average level during 1993-2001			Contribution to difference between 1993 and 2001			Contribution to average level during 1993-2001				Contribution to difference between 1993 and 2001			
	R&D	Articles	Patents	R&D	Articles	Patents	Human Capital	ICT	Diffusion	Corruption	Human Capital	ICT	Diffusion	Corruption
Argentina	-0.26	-0.27	-0.22	0.01	0.04	0.00	-0.04	-0.20	-0.11	-0.21	0.30	0.21	-0.01	-0.16
Austria	0.27	0.17	0.16	0.32	0.15	0.25	0.12	0.21	0.17	0.21	0.08	0.60	0.13	0.07
Belarus	-0.28	-0.27	-0.23	0.01	0.00	0.01	0.02	-0.23	-0.19	-0.17	0.08	0.08	-0.01	0.15
Belgium	0.29	0.22	0.18	0.34	0.13	0.28	0.43	0.19	0.14	0.06	0.11	0.46	0.11	0.11
Brazil	-0.24	-0.31	-0.23	0.04	0.02	0.00	-0.30	-0.24	-0.17	-0.24	0.51	0.19	0.04	0.13
Bulgaria	-0.28	-0.21	-0.23	-0.04	-0.08	0.00	-0.06	-0.16	-0.21	-0.23	0.23	0.16	0.04	0.19
Canada	0.28	0.49	0.45	0.28	-0.16	0.37	0.32	0.31	0.12	0.38	-0.24	0.48	0.19	-0.01
Chile	-0.26	-0.27	-0.22	0.02	0.00	0.00	-0.18	-0.18	-0.12	0.16	0.15	0.29	0.07	0.05
China	-0.29	-0.33	-0.23	0.04	0.01	0.00	-0.43	-0.30	-0.19	-0.30	0.09	0.12	0.06	0.13
Croatia	-0.23	-0.20	-0.22	0.05	0.02	0.01	-0.15	-0.12	-0.15	-0.22	0.05	0.30	0.10	0.18
Czech Rep.	-0.12	-0.10	-0.21	0.09	0.01	0.01	-0.13	-0.06	-0.01	-0.08	0.11	0.51	0.09	-0.22
Denmark	0.41	0.58	0.25	0.47	0.10	0.40	0.26	0.45	0.12	0.45	0.22	0.73	0.18	0.00
Estonia	-0.25	-0.13	-0.22	0.08	0.14	0.01	0.06	-0.04	-0.11	0.01	0.29	0.40	0.11	-0.04
Finland	0.52	0.56	0.51	0.69	0.23	0.65	0.41	0.38	0.05	0.42	0.22	0.60	0.18	0.08
France	0.39	0.21	0.21	0.13	0.09	0.14	0.17	0.21	0.05	0.14	0.02	0.51	0.10	-0.03
Germany	0.45	0.19	0.54	0.24	0.11	0.40	0.09	0.24	0.12	0.27	0.02	0.64	0.06	-0.10
Greece	-0.21	-0.10	-0.22	0.10	0.10	0.01	0.08	0.03	-0.06	-0.09	0.23	0.43	0.12	-0.05
Hong Kong	-0.20	-0.02	-0.08	0.13	0.20	0.17	-0.21	0.31	0.22	0.20	0.01	0.69	0.08	0.12
Hungary	-0.21	-0.12	-0.19	0.05	0.07	0.00	-0.06	-0.10	-0.08	-0.08	0.23	0.40	0.14	0.05
Indonesia	-0.32	-0.34	-0.23	0.00	0.00	0.00	-0.44	-0.33	-0.20	-0.37	0.12	0.03	0.02	-0.06
Ireland	0.06	0.04	-0.06	0.30	0.13	0.17	0.12	0.20	1.24	0.29	0.04	0.65	2.36	-0.17
Israel	0.58	0.72	0.54	0.95	-0.21	0.72	0.02	0.17	0.02	0.20	0.17	0.58	0.05	-0.07
Italy	0.01	0.01	-0.04	0.07	0.10	0.06	0.04	0.12	0.03	-0.16	0.11	0.53	0.09	0.23
Japan	0.65	0.10	1.39	0.27	0.10	0.63	0.07	0.22	0.20	0.11	0.09	0.59	0.05	0.04
Korea	0.14	-0.20	0.14	0.35	0.20	0.44	0.20	0.11	0.06	-0.13	0.28	0.52	0.11	-0.03
Latvia	-0.29	-0.26	-0.22	0.02	-0.01	0.00	-0.02	-0.13	-0.17	-0.25	0.40	0.30	0.10	0.16
Lithuania	-0.27	-0.27	-0.23	0.05	0.04	0.01	-0.05	-0.16	-0.15	-0.12	0.33	0.22	0.03	0.22
Malaysia	-0.29	-0.32	-0.22	0.04	0.01	0.01	-0.33	-0.16	-0.06	-0.04	0.25	0.27	0.04	-0.03

Country	Technology Competitiveness						Capacity Competitiveness							
	Contribution to average level during 1993-2001			Contribution to difference between 1993 and 2001			Contribution to average level during 1993-2001				Contribution to difference between 1993 and 2001			
	R&D	Articles	Patents	R&D	Articles	Patents	Human Capital	ICT	Diffusion	Corruption	Human Capital	ICT	Diffusion	Corruption
Mexico	-0.29	-0.31	-0.22	0.03	0.02	0.00	-0.32	-0.24	-0.16	-0.26	0.19	0.17	0.02	0.07
Moldova	-0.31	-0.30	-0.23	-0.01	-0.02	-0.01	-0.19	-0.28	-0.24	-0.33	-0.11	0.06	-0.01	-0.08
Netherlands	0.34	0.48	0.27	0.22	-0.01	0.23	0.28	0.30	0.21	0.36	-0.05	0.68	0.12	0.02
Norway	0.41	0.36	0.08	0.18	0.05	0.24	0.31	0.47	0.24	0.36	0.07	0.74	0.13	-0.01
Philippines	-0.31	-0.33	-0.23	0.02	0.00	0.00	-0.17	-0.31	-0.21	-0.28	0.04	0.10	0.00	-0.03
Poland	-0.24	-0.20	-0.23	0.02	0.04	0.00	0.04	-0.19	-0.13	-0.09	0.30	0.27	0.09	-0.22
Portugal	-0.19	-0.19	-0.22	0.10	0.14	0.01	0.11	0.02	0.01	0.09	0.22	0.47	0.15	0.03
Romania	-0.28	-0.30	-0.23	-0.03	0.03	0.00	-0.21	-0.25	-0.19	-0.27	0.09	0.14	0.03	-0.10
Russia	-0.24	-0.20	-0.22	0.05	-0.02	0.01	0.03	-0.23	-0.18	-0.35	0.14	0.10	0.00	0.02
Singapore	0.11	0.08	0.02	0.44	0.33	0.48	-0.06	0.30	0.23	0.38	0.44	0.75	0.11	0.05
Slovakia	-0.21	-0.12	-0.22	-0.04	-0.08	0.00	-0.15	-0.12	-0.04	-0.20	0.11	0.36	0.09	-0.02
Slovenia	-0.02	-0.03	-0.19	0.15	0.19	0.08	0.06	0.07	-0.03	0.02	0.38	0.63	0.18	0.03
Spain	-0.11	0.00	-0.19	0.10	0.14	0.02	0.22	0.02	0.03	-0.02	0.13	0.45	0.16	0.32
Sweden	0.77	0.78	0.72	0.68	0.08	0.94	0.41	0.50	0.03	0.40	0.40	0.76	0.14	0.02
Switzerland	0.68	0.82	1.08	0.10	0.14	0.26	0.00	0.45	0.15	0.35	0.09	0.75	0.05	-0.02
Taiwan	0.15	-0.06	0.75	0.31	0.16	1.41	-0.10	0.23	0.05	-0.04	0.14	0.76	0.10	0.09
Thailand	-0.31	-0.33	-0.23	0.01	0.00	0.00	-0.27	-0.28	-0.12	-0.27	0.42	0.10	-0.01	0.03
Turkey	-0.29	-0.30	-0.23	0.03	0.04	0.00	-0.36	-0.18	-0.17	-0.21	0.08	0.21	-0.02	-0.06
Ukraine	-0.25	-0.28	-0.23	-0.06	-0.01	0.00	0.06	-0.26	-0.19	-0.36	0.17	0.06	-0.01	-0.06
U.K.	0.26	0.48	0.17	0.15	0.04	0.21	0.38	0.28	0.05	0.32	0.31	0.59	0.12	0.02
U.S.A.	0.79	0.41	0.62	0.45	-0.16	0.39	0.29	0.47	0.14	0.23	-0.09	0.58	0.22	-0.01

Source: Own computations based on the World Bank (WDI), OECD (MSTI and Patent data), UNESCO, USAID (Global Education Database), ITU (World Telecommunication Indicators), Transparency International (Corruption Perception Index) and RICYT.