NOTTINGHAM TRENT UNIVERSITY

Nottingham Business School

MSc International Finance

Determinants of competitiveness in the European Union and the role of debt

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Abstract

The purpose of this paper is to evaluate the factors that affected European competitiveness, as measured by GDP per capita growth, over the period between 1997 and 2011. Modifying the framework by Fagerberg, Srholec and Knell (2007), we consider seven aspects of competitiveness: R&D, ICT infrastructure, education, financial development, price competitiveness, demand for exports, and debt. We find, inter alia, that debt has been a major factor negatively affecting growth in the full sample of EU-28, as well as all subsamples (including e.g. transitional countries and EU-15). Other factors that were highly relevant for growth were diffusion of ICT, education, and, especially in transitional economies, world demand. Price competitiveness was mostly insignificant, so was financial development. Results for R&D were mixed, based on different model specifications.

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I. Introduction

The economy of European Union is facing a big challenge of improving its competitive position relative to the world‘s most prosperous regions. There are several pieces of economic literature (e.g. Grilo and Koopman, 2006; and Berndt et al., 2015) dealing with the well-known fact that the European Union is still lagging behind the U.S. in terms of GDP per capita (and that the gap has actually increased compared to the first half of 1990s), which is, as suggested by Grilo and Koopman (2006), a reasonable proxy for standard of living in a country and its overall competitiveness. Moreover, the years that followed the financial crisis of 2008 uncovered severe deficiencies in the concept of European monetary union, as the phenomenon accelerated serious hardship that culminated into debt crisis in several advanced countries of the euro area. The literature dealing with this topic usually emphasises the inability of monetary union to function properly by itself, i.e. without forming fiscal union at the same time (e.g. Bordo, Markiewitz and Jonung, 2011; Lane, 2012; and De Grauwe, 2013). As a result, the crisis has further contributed to increasing the gap between the EU and the U.S. Our study aims to identify the factors which affected the growth of GDP per capita (as a proxy for national competitiveness in this context) in European union since 1990s, loosely building on the framework by Fagerberg, Srholec and Knell (2007), which examines the magnitude of four fundamental aspects of competitiveness[1] (technology, capacity, price and demand) on economic growth. We alter the framework, so that we assess six, rather than four, aspects of competitiveness individually, namely: R&D, ICT infrastructure, education, financial development, price competitiveness, and world demand.

Our study provides several important conclusions. Firstly, after running a series of panel regressions (pooled OLS and Fixed effects), we find that on the sample of EU-28 member states, the positive effects of ICT infrastructure and weighted world demand on GDP per capita growth are highly statistically significant in every specification (different combinations of variables), which is consistent with the growth-based literature reviewed in the following section, and R&D and education are highly significant in the specifications including patents granted and enrolment in tertiary education, respectively. The remaining

[1] In fact, term „competitiveness“ has been criticized for that it may be misleading in the national context; specifically, Krugman (1994) argues that unlike corporations, countries do not play a zero-sum game, which means that if one country gains, it does not necessarily cause another country to lose. However, we use the term anyway, as it is commonly used in a number of related academic studies.

variables are statistically insignificant in all specifications. Secondly, our contribution lies in extending the framework by adding the government debt as another aspect of competitiveness, which was chosen with respect to debt crisis in the EU. We found a strong negative correlation between debt and GDP per capita growth over the sample period. Such extended model also considerably alters the results obtained for „no-debt“ specifications, especially in two features: on the one hand, the significance of R&D decreases (and even disappears under Fixed effects), while unit labour costs, on the other hand, become statistically significant with negative sign (even more under Fixed effects).

Eventually, we check the robustness of the results by splitting the full sample of countries (EU-28) into several country groups. We find, inter alia, that the results noticeably differ between the most advanced countries in the sample (represented by EU-15) and the transitional economies, where the growth in the former seems to be mostly driven by improving ICT infrastructure, while in the latter it is world demand that seems to matter the most. In the sample consisting of GIIPS economies, the debt remains as the only significant variable with, quite predictably, the highest magnitude among all country groups.

The rest of the study is organised as follows: Section II is devoted to literature review, Section III explains the methodology and defines the variables used in the econometric model, Section IV examines the implications of individual aspects of competitiveness on economic growth in the sample, Section V provides results of regressions and their interpretation, and finally, Section VI summarizes the conclusions achieved in this work.

II. Literature review

Currently, there are several major emprical works assessing overall competitiveness of nations, which often use a quite different approach to do so; to provide an example, we briefly summarize two of them, namely Fagerberg, Srholec and Knell (2007) and Delgado et al. (2012). The former builds an econometric model theoretically based on modern growth theory, which consists of four fundamental determinants of competitiveness, acting as independent variables: technological competitiveness, capacity for innovation, price competitiveness and world demand for goods and services. The authors examine the impact of these factors on the sample of 90 countries, which includes developed as well as developing countries in several geographic groups. Consequently, they provide the evidence of growing divergence between these groups, where countries like the Asian Tigers gain advantage mainly due to technological progress and enhancing ICT infrastructure, while especially in the case of technological competitiveness, groups such as South Asia and Sub-Sahara Africa fall behind dramatically.

In Delgado et al. (2012), the focus is not on output growth per se, as in the previously discussed paper, but on productivity, which is in line Porter's (1990) definition of national competitiveness. More precisely, the authors define the so-called „foundational competitiveness" as *„the expected level of output per working-age individual given the overall quality of a country as a place to do business."* (Delgado et al., 2012, pp. 8) Also, the set of determinants in the model markedly differs from the ones used by Fagerberg, Srholec and Knell (2007), as independent variables are represented by the following: microeconomic environment, social and political infrastructure and government and monetary policies, where the composite indicator of microeconomic environment is based on the fundamental elements of national competitiveness in Porter's national diamond. The overall result of the work is ranking countries based on their competitiveness score, therefore, in other words, the result of the work is basically a new composite competitiveness index.

Both models allow to identify weak points of individual economies, respectively groups of economies and provide important policy recommendations to foster competitiveness. The model we build later in this work is based on the model by Fagerberg, Srholec and Knell (2007). The topic of competitiveness covers a lot of different areas of economic theory, whose understanding is essential before attempting to interprete the model's results. Therefore, the following text will be dedicated to detailed literature review related to each of the growth determinants entering into our framework.

Technology

Fagerberg, Srholec and Knell's (2007) model of growth has its foundations in endogenous growth theory, pioneered by Lucas (1988) and Romer (1990). Capital accumulation, as a main focus of neoclassical theories of growth, generally failed to capture the patterns of economic growth. For instance, in Solow's model applied in U.S., growth of physical capital explained very little of economic growth variations, with the substantial part being attributed to technological change instead. (Solow, 1957; Helpman, 1991) Unlike in previous growth models, such as the one by Solow, or Arrow (1962), which considered knowledge as an exogenous variable, in endogenous theories, technological progress is the result of purposeful investment of private agents. In general, this „new" strand of literature meant a major shift of focus from accumulation of physical capital to quantity and quality of human capital. In Lucas's understanding, human capital may be accumulated in two ways: education and learning-by-doing, where he considered both of them equally important in this matter. As Aghion et al. (1998) point out, Lucas considers human capital as another input, whose growth contributes to the growth of the economy. This approach is in contrast with Nelson-Phelps' (1966) approach, according to which level of human capital, rather than its growth rate, implies the growth of innovations which eventually determine the growth of output. Romer (1990), similarly to Lucas, came to a conclusion that increasing human capital stock leads to faster economic growth. His focus was on investment in research and development – in order to foster economic growth, he suggests that policies which subsidize research activity are more effective than policies subsidizing accumulation of physical capital, even though the research is eventually reflected in capital goods. As he states, *„if the fundamental policy problem is that we have too many lawyers and MBAs and not enough engineers, a subsidy to physical capital accumulation is a weak, and possibly counterproductive, policy response."* (Romer, 1990, pp. 594)

In the same year as Romer's work was published, Aghion and Howitt (1990) offered a different perspective on technology and its impact on growth, in that technological progress may result in losses as well as gains, under certain circumstances. It is based on the Schumpeter's statement that innovation (not only product innovation per se, but also innovation in production processes, transportation, etc.) „*incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one. This process of Creative Destruction is the essential fact about capitalism."* (Schumpeter, 1942). One of the negative aspects of this phenomenon is the potential deterrence of current innovation activity (which is a major determinant of growth), if there is a prospect of high level of research in the future.

In Grossman and Helpman (1994), the authors discuss the long-term sustainability of growth. Among other things, they emphasize the scarcity of natural resources and that innovation in production processes, which allows for greater efficiency and as a result higher preservance of natural resources, is probably the only way of preventing economic growth from stagnation or even continuous decline in the future. Furthermore, they also summarize the findings from their previous work (Grossman and Helpman, 1991) regarding the relationship between growth and size of the economy. The authors criticize previous models of endogenous growth for the fact that *„a common feature of [these] models ... has been that larger economies grow faster“*, whereas they claim that *„in general, only accumulation of factors that are used intensively in the growth-generating activities guarantees faster growth.“* (Grossman and Helpman, 1991, pp. 23, 24). Thus, a large country with mostly unskilled population may grow at a slower rate than a small country with highly-skilled individuals.

Another aspect partially covered in the work by Grossman and Helpman (1991), and previously by Romer (1990), is the importance of technological spillovers as a major source of growth, along with the domestic innovation activity per se (also in Nelson and Wright, 1992; Coe and Helpman, 1995; Evenson and Singh, 1997; etc.). Technological spillover means, for instance, that once certain technology is developed (or research is undertaken), it becomes available to others, who may productively exploit the newly obtained knowledge and further contribute to economic growth. If these spillovers exist only on the national level (not the global), they might become a source of increasing growth divergence between countries. (Fagerberg, 1996) Nelson and Wright (1992), however, point to an increasing tendency of international technological spillovers, driven by transnational corporations. Furthermore, Evenson and Singh (1997) found a solid evidence of cross-border technological spillovers considerably contributing to productivity growth in selected Asian countries. However, according to Acemoglu and Zilibotti (1999), even if the least developed countries gain access to the newest technologies, the lower-skilled labour in these countries could not use it in such extent as the high-skilled labour in developed countries, and therefore could not achieve their productivity levels. This makes a point for the interrelation between education and technology in the posterior part of the paper.

Acemoglu, Garcia and Zilibotti (2012) also examine the process of product standardization following the innovation, and its implications on growth. The effect of standardization on growth is twofold. On the one hand, technology diffusion and its applicability by lower-skilled labour imply increase in output. On the other hand, this *„business-stealing“* effect tends to destimulate from innovation.

Education

As mentioned earlier, the growth literature based on technological progress and education is highly interrelated, which is already noticeable in the groundbraking papers by Lucas (1988) and Romer (1990). This relationship is obvious; the necessary condition of continuous innovation process is a base of highly-skilled innovators, whose knowledge is from large part a result of quality education.

Most of empirical works in this area find positive relationship between the stock or growth of human capital (mostly represented by education variables) and economic growth; however in two notable cases – Benhabib and Spiegel (1994) and Barro and Sala-i-Martin (1995) – the models indicated insignificant effect of change in schooling on economic growth. These works were, however, criticised by several economists, including Krueger and Lindahl (2001). The authors found, contradictorily to these papers, that change in schooling affects growth with a positive sign, as soon as measurement errors are accounted for.

Gemmell (1996) contributed to the education-related growth literature primarily in two aspects. Firstly, according to the author, the most commonly used indicator of human capital – school enrolment rate – fails to distinguish whether growth is a result of human capital initial stock, or its accumulation over time, and therefore its usage in empirical models might lead to inaccuracies in interpretation (this finding was later supported by Hanushek and Kimko, 2000). After separating the two effects, the author found that both of these effects have a positive impact on economic growth. Secondly, the author supplements Romer's (1990) finding of the indirect impact of human capital on economic growth (where human capital stimulates physical capital investments, which eventually induce growth) by finding a direct relationship between the two variables as well. The criticism of well-established proxies for human capital continued in the work by Hanushek and Kimko (2000), but this time in a different manner. The authors point out that the indicators of human capital tend to be mostly quantitative, rather than qualitative, even though it is often the latter that matters the most. Obtaining cognitive tests' results on the sample of 31 countries, which served as a proxy for the quality of education (respectively human capital), led them to a conclusion that *„labor-force quality differences measured in this way prove to have extremely strong effect on growth rates“.* (Hanushek and Kimko, 2000, pp. 1185)

Another education-related issue with potential impact on growth is cross-border movement of skilled individuals, which is sometimes referred to as „brain-drain“. This topic is the center of interest in Wong and Yip (1999), where the authors find that such migration of intelligence has a considerable negative impact on economic growth and therefore they recommend the goverments of countries hit by this phenomenon to intervene by increasing spending on education.

ICT infrastructure

While theory and economic intuititon predict a clear positive effect of growing ICT infrastructure on economic growth, the results tend to vary based on whether developed or developing countries are examined. Several works find evidence for positive relationship between ICT infrastructure and growth for developed countries, but not for developing countries (e.g. Dewan and Kraemer, 1998; or Lee, Gholami and Tong, 2005). Both Dewan and Dewan and Kraemer (1998) and Lee, Gholami and Tong (2005) remark the so-called „productivity paradox“, which is associated with Solow’s (1987) famous statement that *„[one] can see the computer age everywhere but in the productivity statistics.“* (pp. 36) The statement was a reaction to the fact that despite massive growth and diffusion of ICT in the U.S., there had been little effect on economic growth. Both studies also share the opinion that the low correlation between ICT infrastructure and growth in developing countries may be due to little experience with such technology and therefore after obtaining this experience, ICT may become a significant contributor to these countries‘ growth in the future.

Conversely, a number of studies conducted research on the sample consisting primarily of developing countries, obtaining contradictory results to the ones discussed earlier (e.g. Yoo, 2003; Nasab and Aghaei, 2009; or Sassi and Goaied 2013). Nasab and Aghaei (2009), for instance, found that ICT positively affects growth in OPEC countries, but also emphasise that in order to make the policies aimed at increasing ICT infrastructure more effective, investment in human capital and favourable social and cultural infrastructure are essential.

Studies by Timmer, Ypma and Ark (2003) and Seo, Lee and Oh (2009) examine the possible causality between ICT infrastructure invesment and growth gap between countries. Especially the former is highly relevant for our research, as it evaluated the impact of ICT on labour productivity growth in EU and the U.S., and labour productivity gap is one of the most serious issues worrying the economy of EU, especially after the recent crisis. (Berndt et al., 2015) They found that both ICT invesment and non-ICT investment played a role in widening this gap. Seo, Lee and Oh (2009) arrived to the same conclusion on the sample of 29 developed and developing countries. Moreover, unlike Dewan and Kraemer (1998), the authors found positive relationship between ICT investment and growth, regardless of whether it was in developed or developing countries.

Another paper, which came to a conclusion that fostering ICT diffusion is a major source of economic growth, is Vu (2011), who tested the hypothesis on the sample of 102 countries.

According to his results, penetration of internet has the highest positive impact on economic growth, out of the three tested proxies (penetration of mobile phones and personal computers being the other two).

Financial system

Literature that examines the ability of financial system / development to generate growth provides mixed results. While Schumpeter (1911) in his pioneering work argues in favour of financial system's effect on economic growth, due to features such as assembling savings, risk management, and eventually fostering technological progress, Lucas (1988) is not convinced by the relationship.

The first group of studies suggest an existence of positive relationship between financial development and growth (e.g. King and Levine, 1993; Rajan and Zingales, 1996; Levine, Loayza and Beck, 2000; Arestis, Demetriades and Luintel, 2001; Kroszner, Laeven and Klingebiel, 2007; Huang and Lin, 2009; and Leitão, 2010), but offer different perspectives on the matter. Rajan and Zingales (1996) show that industries largely dependent on external financing grow at a considerably higher rate in those countries, where financial markets are more developed. These results are supported in the work by Kroszner, Laeven and Klingebiel (2007), however the primary aim of their work was to examine the effect of banking crises in this context. As expected, industries dependent on external sources of finance experienced a much stronger decline during banking crises in those countries, where financial systems were highly developed.

Financial development may be examined separately in banking sector and in stock markets, as in the work by Arestis, Demetriades and Luintel (2001). The authors find that both of these positively affect economic growth, the former, however, with much higher magnitude.

The difference in relationship between financial development and growth based on the stage of economic development was examined by Huang and Lin (2009). On the sample of 71 countries, they found that the relationship tends to be stronger in low-income countries. Therefore, the authors point to the importance of innovation and deregulation of financial system to promote growth in these countries.

The finance-growth relationship has already been examined on the sample of EU countries as well, where Leitão (2010) found a positive relationship between financial development and growth on the sample of EU-27 countries and BRICs during the 1980-2006 period.

On the contrary, there are several papers which suggest that the positive relationship cannot be generalized (e.g. Ram, 1999; Barajas, Chami and Yousefi, 2013), or find only weak evidence of relationship between financial development and growth (e.g. Favarra, 2003), or find this relationship to be significant but negative (e.g. De Gregorio and Guidotti, 1995; and Ben Naceur and Ghazouani, 2007), which is, however, quite rare. Moreover, in De Gregorio and Guidotti (1995), the negative coefficient was obtained in the case of Latin America countries, which was, according to the authors, caused by *„extreme liberalization of financial markets followed by their subsequent collapse [in these countries].“* (pp. 443) In another case, Ben Naceur and Ghazouani (2007) separated banking development from stock market development, similarly as in Arestis, Demetriades and Luintel (2001), and found the negative effect of stock market development on growth in MENA countries after controlling for development of banking sector.

Price-and-cost competitiveness

Competitiveness of nations was long believed to be captured in the price and cost indicators (such as relative export / import prices, or relative unit labour costs (RULC)). However, relying solely on these indicators was subject to criticism, as these measures were unsuccessful in explaining countries‘ prosperity in several empirical works (e.g. Kaldor, 1978; Fagerberg, 1988; and Fagerberg, Srholec and Knell, 2007). Probably the best known is Kaldor‘s (1978) interpretation, as his findings (commonly known as „Kaldor’s paradox“) prove that price competitiveness indicators on their own fail to reflect countries’ competitiveness reliably. As Fagerberg (1988) remarks, *„if unit labour costs grow more than in other countries, it is argued, this will reduce market shares at home and abroad, hamper economic growth and increase unemployment.“* (pp. 355) However, Kaldor noticed that in the post-war period, several countries, including West Germany, Japan, and Italy, experienced an increase in their market share, which even exceeded their production growth rate, while the United Kingdom and the U.S., on the other hand, suffered respective losses; the paradox is in the finding that the unit labour costs in the United Kingdom and the U.S. rose, in fact, at slower pace than in the competitiveness-gaining countries over this period. The main conclusion is therefore that considering non-price competitiveness indicators is inevitable in order to obtain a more accurate picture of country’s competitiveness development. This conclusion is partially supported by Fagerberg (1988), as he attributes a substantial part of countries‘ international competitive position[2] to technological and capacity competitiveness, whereas he finds the impact of price competitiveness to be only marginal. However, in Fagerberg (1996), the author does not reject the concept of price competitiveness completely; he admitted its justification in low-tech industries, such as textiles and clothing, or even chemical industries, even despite the high technological progress present in the latter.

Foreign trade

This subsection will be devoted to literature dealing with the causalities of countries‘ trade policies and exports on economic growth. Regarding the latter, there is an apparent direct relationship between exports and gross domestic product (as net exports enter into the equation for GDP). However, wide range of publications examine the indirect effects of exports on growth, or in other words, certain side-effects affecting different aspects of economic growth. Empirical works in this area are mostly oriented on developing countries, which is natural, as developing countries are usually the ones with substantial barriers on trade, while they could potentially benefit from engaging in international trade. There are currently only two countries in the EU categorized as developing (Romania and Bulgaria), but more of the current members (transitional economies in Central Europe and Baltic regions) were among developing countries sometime over the past 20 years, therefore literature reviewed in this subsection might provide an explanation for their economic development.

Major economic institutions, such as IMF, OECD or World Bank, have historically promoted liberalisation of international trade and outward-oriented policies to stimulate growth and long-term economic development. This policy recommendation is supported by a number of empirical publications (e.g. Balassa 1978; Tyler, 1980; Krueger, 1998; Stiglitz, 1998; Frankel and Romer, 1999; and Rodriguez and Rodrik, 2001), which come to a common conclusion that developing countries that are open to foreign trade and have an outward-oriented approach achieve in general higher growth rates. The hypothesis of positive causal link from exports to growth tested in these studies is often reffered to as ELG (export-led growth) hypothesis.

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[2] Sample consisting of 15 OECD countries.

The issues of foreign trade and technological progress meet in the work by Coe and Helpman (1995). The authors found that international technology spillovers play a significant role in generating growth through increase in total factor productivity (as discussed already in subsection devoted to technology), but they add that the spillover effect depends on counries‘ openness to foreign trade, where small open economies benefit from foreign R&D more relative to larger and more closed economies.

One of the issues of EU economy is slower than intended convergence between the member states. (Berndt et al., 2015) The paper by Ben-David (1996) examines the issue of convergence in relation to foreign trade with the conclusion that income gap between countries, which participated in trade within their „trade-based country group“, declined in most of these groups. Moreover, grouping based on trade rather than common language resulted in stronger convergence effect.

Papers by Singer and Gray (1988) and Poon (1994) examine the impact of world demand on export performance of developing countries. The former concludes that strong external demand is necessary for countries to benefit from exports (in terms of growth), and that the causal link between exports and growth differs among countries due to different market conditions. The author therefore suggests that policies towards openness and outward orientation are not suitable under any circumstances for any country. Poon (1994) obtains similar results, but contradicts Singer and Gray’s findings in that even if the world demand is temporarily weak, it may be compensated by high trade competitiveness of the country.

Government debt

After the recent financial crisis, many advanced countries, particularly in Europe, experienced a rapid increase in their souvereign debts, which may have had a severe impact on the dynamics of economic growth through several channels. Framework by Fagerberg, Srholec and Knell (2007) does not capture the impact of debt, however, due to our orientation on EU economies, we find it a highly relevant potential determinant of growth in the-post crisis period.

The relationship between debt and output was already examined in the work by Barro (1979). His evidence suggests the inverse relationship through taxation channel – specifically, according to the author, debt service is to be financed by distortionary taxes in the future, which negatively affect capital accumulation and eventually growth.

Elmendorf and Mankiw (1999), inter alia, highlight the differences in debt-growth relationship based on whether we observe short-term or long-term effects. In the short term, debt causes an increase in aggregate demand (under Keynesian assumptions of inflexible wages, prices, etc.) which subsequently increases output. In the long-run, on the other hand, debt financing may crowd out domestic investment and lead to economic slowdown.

Kumar and Woo (2000) find a negative causal link between debt and growth, where slowdown of investment due to rising debt and the resulting decline in labour productivity imply decline in growth of national income. However, a number of studies, including Reinhart and Rogoff (2000) and Checherita and Rother (2010) find such relationship significant only above certain debt threshold – in other words, the debt-growth relationship a has a shape of inverse U – the relationship between the variables of debt and growth is positive until certain debt-to-GDP ratio is exceeded and the relationship becomes opposite. Especially the latter of the studies is highly relevant in our case as the result was obtained on the sample of euro area countries, where the turning point was found to be around 90-100% GDP.

Debt may affect growth through interest rate channel as well, as several studies conclude (e.g. Gale and Orszag, 2003; Engen and Hubbard, 2004; and Baldacci and Kumar, 2010). It is mostly explained as a consequence of deterrence from investment due to increasing interest rates, which are the result of debt expansion. Another channel – fiscal inflation – is the subject of reseach in Cochrane (2011), which finds the link between government debt and inflation in the U.S, which combined with Barro‘s (1995) finding of inverse causal relationship between inflation and growth supports the existence of negative impact of debt on economic growth.

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III. Data and methodology

The model we use in this work is inspired by Fagerberg, Srholec and Knell (2007), whose model specification includes four fundamental pillars of competitiveness, represented by composite indicators for technology, capacity, price and demand competitiveness. The primary difference between their specification and ours is in that while these authors worked with cross-sectional data, we use panel data. The reason is especially that our sample of countries is much smaller than the one analysed by the authors (28 versus 90), as well as reasonable data availability over the analysed sample period. Specifically, our analysis focuses on the sample of the current EU member states (EU-28) over the 16-year period between 1996 and 2011.

Building on the literature reviewed in the previous section, our model is further modified as follows: the broad composite indicators are replaced by individual variables – specifically, the *Technology* indicator used by Fagerberg, Srholec and Knell (2007) is divided into individual proxies for *R&D* and *ICT infrastructure*, and similarly, *Capacity* indicator is represented by proxies for *Education* and *Financial development*. Furthermore, instead of GDP growth as a dependent variable, we use the first differences of GDP per capita (as an approximation of GDP growth), so the formula in its basic form may be formulated as follows:

$$d\_l\_GDPpc_{i,t} = a_0 + a_1\, l\_GDPpc\_i_{i,t} + a_2\, d\_l\_R\&D_{i,t} + a_3\, d\_l\_ICT_{i,t} + a_4\, d\_l\_Education_{i,t} + a_5\, d\_l\_Finance_{i,t} + a_6\, d\_l\_Price_{i,t} + a_7\, d\_l\_Demand_{i,t} + \varepsilon_i, \quad (1)$$

where *d* means first difference, *l* is logarithm, $GDPpc_{i,t}$ is GDP of country *i* in time *t*, a_0 is a constant, $a_1 – a_7$ are regression coefficients, *GDPpc_i* is GDP per capita in the initial year, *R&D* is a proxy for research and development, *ICT* is a proxy for ICT infrastructure, *Education* is a proxy for schooling, *Finance* is a proxy for financial development, *Price* is a proxy for price competitiveness, *Demand* is a proxy for demand competitiveness and ε_i is an error term. The indicator of GDP per capita in the initial year serves as a measure of potential for diffusion, as Fagerberg, Srholec and Knell (2007) call it, where a higher level of initial GDP per capita is expected to affect growth negatively; it is due to the assumption of convergence among countries – the countries that currently fall behind are expected to grow at a faster rate than the countries at the technological frontier. All the independent variables are in the logarithmic form, which allows us to better interpret the magnitude of each variable in the model.[3] In the next step, the model is further expanded by an additional variable – *Government debt*. The intuition behind including this variable is the impact of the recent souvereign debt crisis, hugely affecting several EU's advanced economies (especially GIPS), on their subsequent economic growth, where we suggest that this variable will have a major role in explaining the EU member states' patterns of growth in the post-crisis period. Then, the expanded model may be rewritten as follows:

$$d\_l\_GDPpc_{i,t} = a_0 + a_1\, l\_GDPpc\_i_{i,t} + a_2\, d\_l\_R\&D_{i,t} + a_3\, d\_l\_ICT_{i,t} + a_4\, d\_l\_Education_{i,t} + a_5\, d\_l\_Finance_{i,t} + a_6\, d\_l\_Price_{i,t} + a_7\, d\_l\_Demand_{i,t} + a_8\, d\_l\_Debt_{i,t} + \varepsilon_i, \quad (2)$$

where *Debt* is a proxy for government debt.

Data

Choice of the indicators to be used in our framework was made with respect to findings from various growth-related empirical studies. This subsection is devoted to definition and justification of the use of these variables, which are grouped by the aspect of competitiveness they represent. Data sources are listed in *Appendix A*.

R&D

There are several ways of measuring the level of research and development in a country, with R&D expenditure and patent-based indicators being the most common choices. The two R&D proxies are at the opposite sides of innovation process, where the former is a technology-input measure, while the latter is basically an outcome of innovation – therefore a technology-output measure. (Fagerberg, 1996) While in Fagerberg, Srholec and Knell (2007) the authors omit the indicator of R&D spending because of lack of data (little data available in the beginning of 1980s, plus a sample including a big proportion of developing countries with poor data availability), we include this variable as the issue of missing data is not that severe in our case. The issue of incomplete data is, however, present in the case of our second R&D-related indicator – EPO total patents granted – whose data are only available until 2011. Therefore to ensure comparability, the sample period was shortened for all model specifications (i.e. even for those that do not include EPO patents

[3] Fagerberg, Srholec and Knell (2007) use a different stadardization procedure; the variables are standardized by deducting the mean and dividing by the standard deviation.

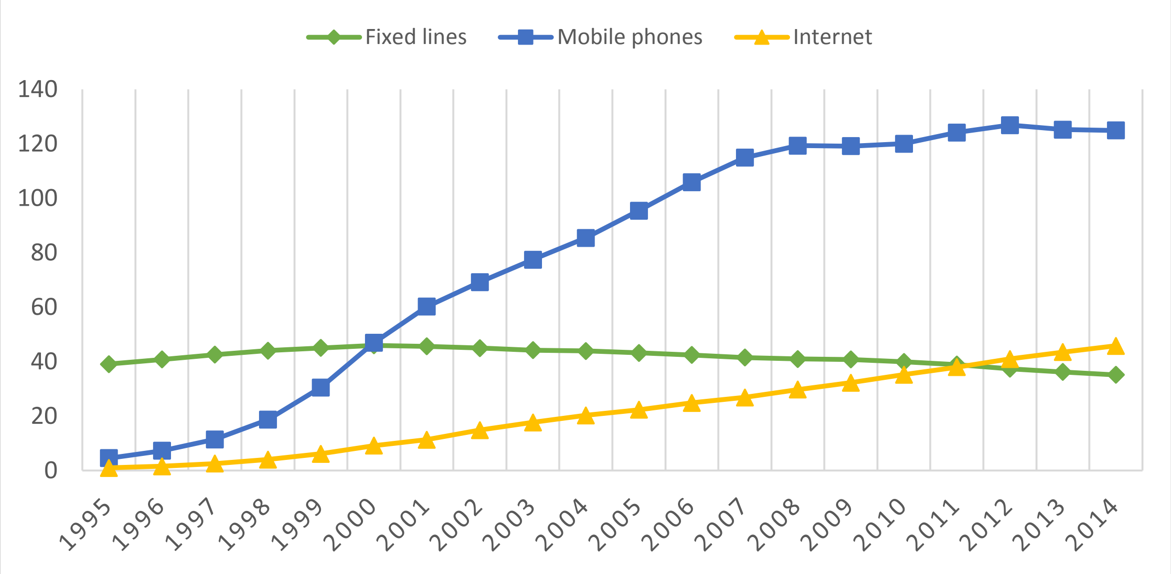
granted). Over the reduced period, however, the percentage of missing data for R&D spending is considerably higher than that of EPO patents granted (6,4% versus 0%). The indicator of R&D spending was also chosen with respect to inclusion of the U.S. in graphical analysis, whereas EPO patents-granted is probably more suitable for comparing the EU member states only. Nevertheless, inclusion of either of these variables (R&D expenditure or patents granted) in the model should lead to a similar outcome, as Fagerberg (1987) suggests there is a high correlation between the two variables at the national level. R&D expenditures are expressed as a percentage of GDP and patents granted are in the ‚per capita' form, to ensure mutual comparability between countries, and reported based on the inventor's country of residence.

ICT

In Fagerberg, Srholec and Knell (2007), the authors use an indicator of number of fixed lines per capita, which, in the current era of internet and mobile technology, is arguably not a sufficient indicator of ICT base in developed countries anymore. As illustrated in *Figure 1*, the average number of fixed lines per capita in EU (including all the current members) has stagnated since the beginning of the sample period, and has been even moderately declining since the turn of the millenium (almost 24% decline in fixed lines per capita since 2000), while the penetration of internet and mobile phones has grown rapidly (almost 400% increase in the former and approximately 166% increase in the latter since 2000, although the mobile-phone penetration has seemingly already stabilized over the past few years).[4]

[4] EU-28 average; source: WDI

Figure 1: ICT penetration, EU-28 average, per 100 inhabitants; 1995-2014



Source. own calculations based on data from WDI

Therefore, we omit the telephone lines and use the penetration of mobile phones and internet, as two of the three measures proposed by Vu (2011) (together with personal computer users), in our model instead. Both variables are expressed as ‚per 100 inhabitants'.

Education

Education, the first of the two subcategories of capacity competitiveness[5] in our model, will be represented by the indicators of education enrolment (secondary and tertiary), as used in Fagerberg, Srholec and Knell (2007) (the authors also use average years of schooling, but we exlude this variable due to insufficient data availability). Despite the fact that the explanatory power of school attainment per se has been challenged, for simplicity and due to limited data availability on cognitive skills of the population, which is a usual proxy for quality of education (e.g. Hanushek and Kimko, 2000; and Hanushek and Wößmann, 2007), we do not take this aspect of education into account; therefore we rely solely on its quantitative aspect. We use gross enrolment ratios expressed as a percentage of population in the secondary / tertiary education age.

[5] Capacity competitiveness may be briefly defined as the ability to exploit the technological advance (Fagerberg, Srholec and Knell, 2007)

Finance

The second subcategory of capacity competitiveness is captured by financial development indicators. The reason for inclusion of financial system indicators in the context of capacity competitiveness is well outlined by Schumpeter (1911), as cited by Levine (1997): *„well-functioning banks spur technological innovation by identifying and funding those entrepreneurs with the best chances of successfully implementing innovative products and production processes.“* (pp. 688)

We consider two measures of financial development, namely *relative size of the financial sector* (represented by the indicator of financial depth, equal to liquid liabilities (M3) as a percentage of GDP) and *domestic credit to private sector* (likewise as a percentage of GDP). The prior is inspired by King and Levine (1993), which the authors found to be strongly correlated to economic growth, while the latter is among the indicators used by Fagerberg, Srholec and Knell (2007). The importance of the latter is enhanced by the fact, that EU is characterised by a relatively high dependence on finance from banking sector, compared to e.g. U.S., which, in case of possible credit constraints, is more flexible in substituting bank loans for debt issuance on capital markets. (Darvas, 2014)

Price

Price competitiveness will be, similarly as in Fagerberg, Srholec and Knell (2007) proxied by unit labour costs (total labour costs per employee as a percentage of GDP per person employed). The outcome of including price competitiveness is difficult to predict (theory expects a negative sign, but recall Kaldor's paradox, 1978) and may significantly differ across different groups of countries. The authors, as well as Fagerberg's previous studies (1987, 1996), find that price competitiveness affects growth only moderately at best, and therefore argue that the concept of price (or cost) competitiveness as a main focus in assessing national competitiveness is „outdated“. However, we do not omit the indicator to check whether the relative insignificance of the factor holds in our sample, and also for purposes of comparison of the indicator‘s magnitude in different country groups.

Demand

We compose the indicator of demand competitiveness building on the method by Fagerberg, Srholec and Knell (2007), where the world demand is proxied by total exports of countries in the sample period each year. As in the authors‘ specification, in order to obtain the final value for demand in a particular country, the overall proxy for world demand is weighted by the country's export specialization in different groups of products. Products are grouped according to Lall classification, which divides products into 11 technological categories (from primary products to high-tech manufactures). Our variable specification, however, does not capture the growth of world demand, but rather its state each year. Thus, the indicator for country *i* in time *t* is calculated using the following formulas:

$$Demand_{i,t} = \sum_{j=1}^{m}(W_{j,t} \times s_{ij,t}), \qquad (3)$$

$$W_{j,t} = \sum_{i=1}^{n} X_{ij,t}, \qquad (4)$$

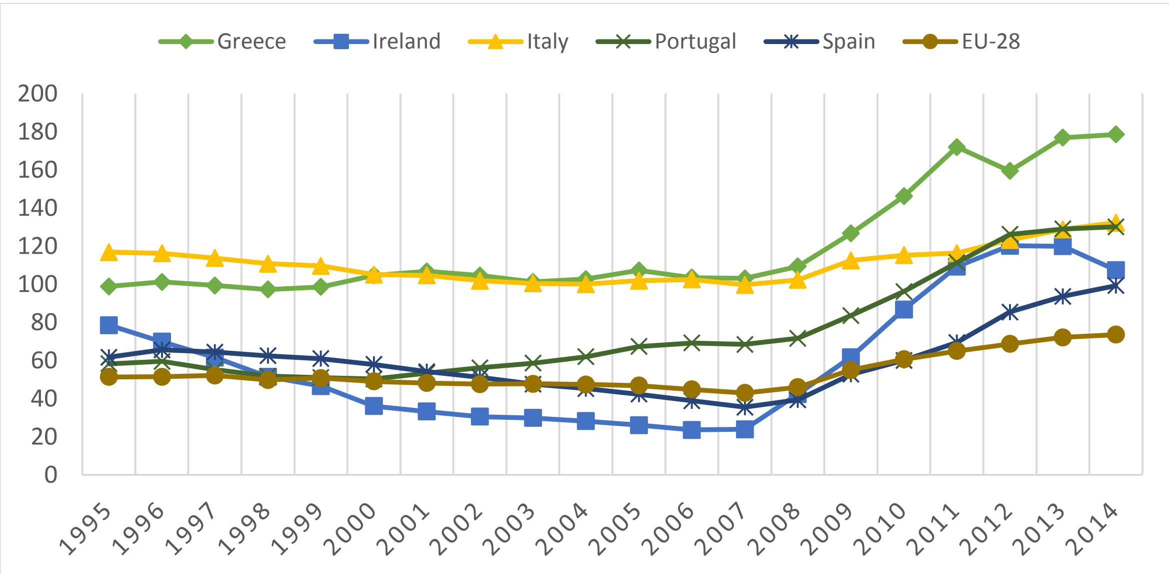
$$s_{ij,t} = \frac{X_{ij,t}}{\sum_{j=1}^{m} X_{ij,t}}, \qquad (5)$$

where $W_{j,t}$ is world demand for product group *j* in time *t*, X_{ij} are exports by product group of country *i*, and s_{ij} is share of product group *j* on total exports of country *i*.

Debt

One of the most important contributions of this work stems from expanding the framework in Fagerberg, Srholec and Knell (2007) by an additional variable, unquestionably relevant in the context of the recent EU debt crisis – the government debt (expressed as a percentage of GDP). *Figure 2* captures the evolution of government debt in debt-crisis-struck countries compared to EU average.

Figure 2: Government debt, GIIPS and EU-28 average, % GDP; 1995-2014



Source: Eurostat

Financial crisis of 2008 has accelerated the growth of government debt across EU member states, but especially five countries (Greece, Ireland, Italy, Portugal and Spain; from now on referred to as GIIPS by their initials) have considerably exceeded the 60% of GDP threshold established in the *Maastricht treaty*. The government debt in Greece has increased by more than 75 percentage points between 2007 and 2014, in Ireland it was even more – almost 84 percentage points increase. What is important is that all five countries have also entered the threshold / band found by Checherita and Rother (2010) to be the turning point for EU (90-100% of GDP), from which the causal link between debt and growth becomes inverse.

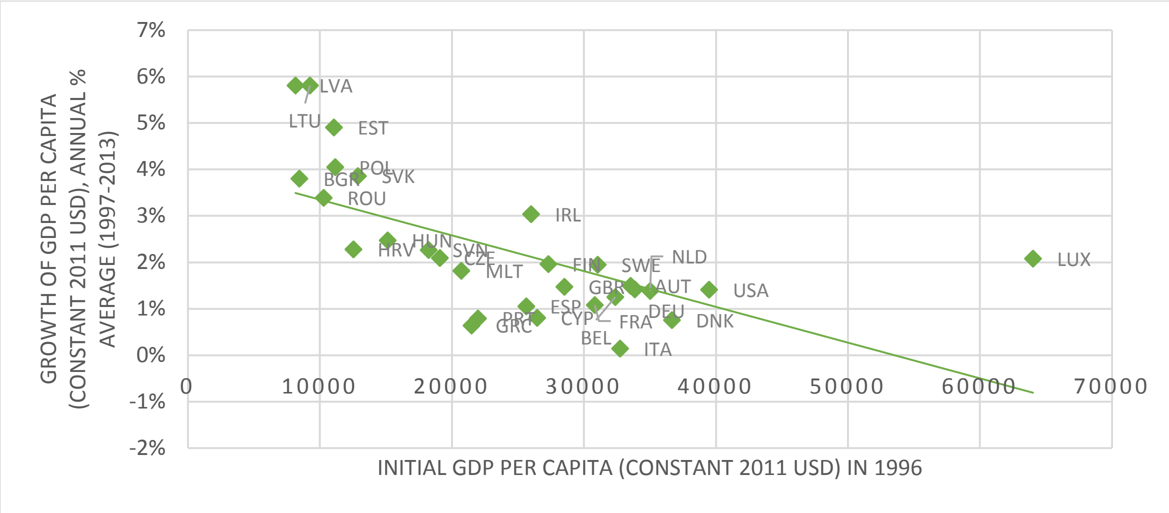
IV. Aspects of competitiveness

Before we assess the outcomes of the model per se, we begin this section by looking at the impact of each of the seven aspects of competitiveness defined in the previous section on growth individually, to examine whether there is a clear relationship, and to compare the outcome in different countries. We do so by comparing average growth GDP per capita during a certain period (1997-2013 in most cases) with growth of a selected variable over the same period, and visualize the relationship using XY plot, with the exception of potential for diffusion, where we use initial GDP per capita in 1996 as independent variable. We include only countries with no more than 3 missing obervations for the particular indicator.

Convergence between countries

The relationship between initial GDP per capita and average growth over the period is visualized in *Figure 3*. There is a strong statistical significance of the relationship, which means that there is a noticeable convergence tendency between the EU member states, and between EU member states and the U.S.. Predictably, countries of the former socialist bloc grew on average the most, especially the baltic countries (i.e. Latvia, Lithuania and Estonia), followed by Central European countries (Poland and Slovakia) and Balkan countries (Bulgaria and Romania), while the original members together with a few later entrants and the U.S. with high initial GDP recorded considerably lower average growth. Luxembourg seems to be an exception, as it recorded growth almost equal to sample’s average, despite having by far the highest initial GDP per capita (1,9 times as high as that of Germany and 1,6 times as high as that of the U.S.).

Figure 3: Initial GDP per capita (1996) versus GDP growth (1997-2013)

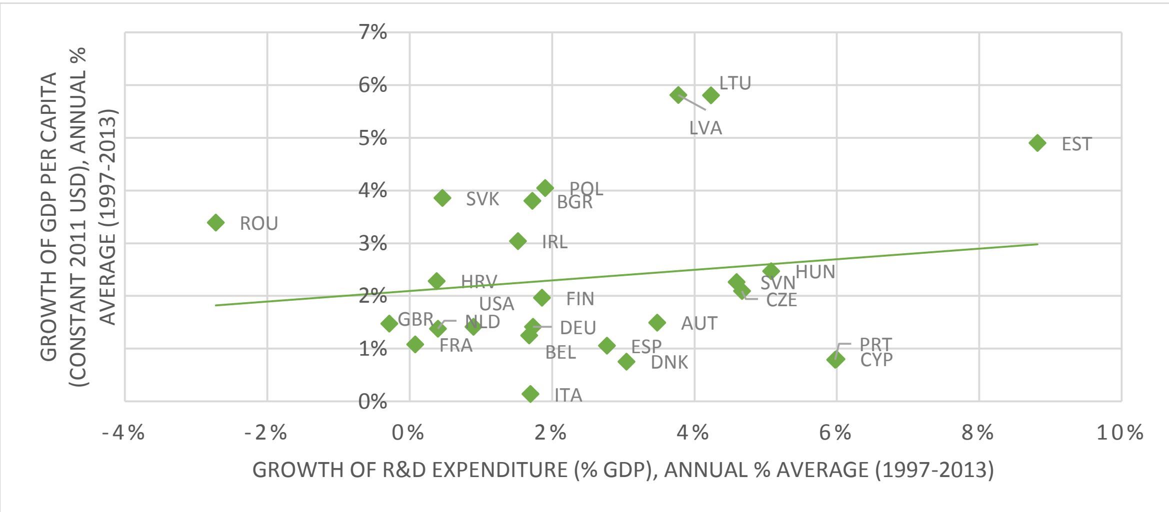


Source: own computations, using the data from WDI

R&D competitiveness

As previously discussed, we use two types of R&D indicators: R&D inputs (represented by expenditure on research and development) and R&D outputs (proxied by patents granted), visualized against growth of GDP per capita in *Figures 4 and 5*, respectively.

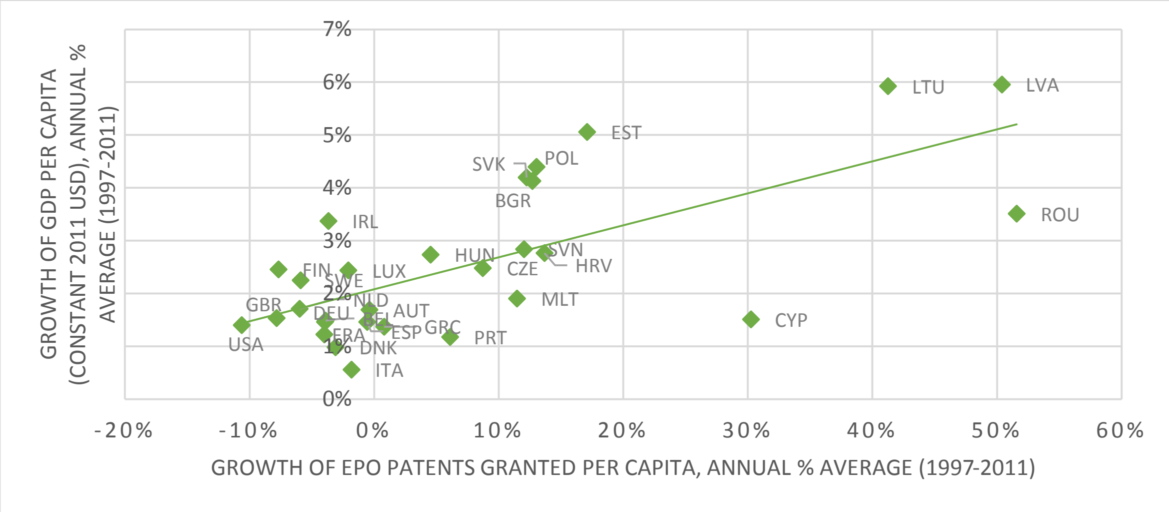
Figure 4: Growth of R&D expenditure versus GDP growth (1997-2013)



Source: own computations, using the data from WDI

The relationship between R&D expenditure and GDP per capita growth is not as straightforward as one would think (p-value implies it is statistically insignificant). However, the result seems to be biased mainly by the fact that GIPS countries show an average growth of R&D spending comparable (or even higher in several cases, Portugal in particular) to that of the fastest-growing EU countries, but fall behind in terms of GDP growth rate due to severe impact of debt crisis (Greece is not included, but available data suggest that the same applies to this country as well). Moreover, four countries were eliminated from the analysis due to insufficient data availability, namely Greece, Luxembourg, Malta and Sweden, which also weakens the explanatory power of the result.

Figure 5: Growth of EPO patents granted versus GDP growth (1997-2013)



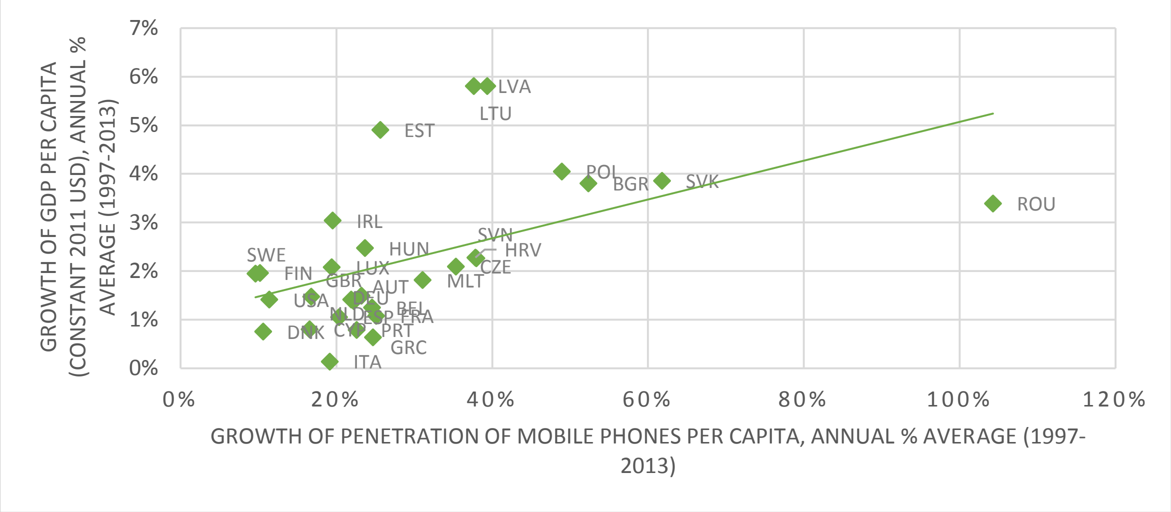
Source: own computations, using the data from OECD Patent Database

Patents, on the other hand, show a reasonable evidence that technological progress played a significant role in accelerating growth of GDP per capita in transitional economies (Central Europe, Balkan and Baltic countries). What is interesting, however, is that while Romania, as only one of the two countries together with the United Kingdom that experienced a negative average growth of R&D expenditure (but at a much higher rate in the former, as it approached 3% per annum), it was the country with the highest average growth of patents granted per capita, which proves that the amount of inputs in and outputs from research are not always related. One of the possible explanation for the phenomenon may be the finding by Pavitt (1982), according to which „patent-to-r&d" ratio significantly differs accross different industrial sectors, which would imply that Romania seems to specialize in sectors with high patenting activity relative to R&D spending.

ICT competitiveness

Figure 6 illustrates a strong statistically significant relationship between penetration of ICT infrastructure represented by mobile phones per capita and GDP per capita growth. The catching-up effect is apparent – Romania stands out again in this matter, with an average growth of mobile-phone penetration even exceeding 100% per annum.

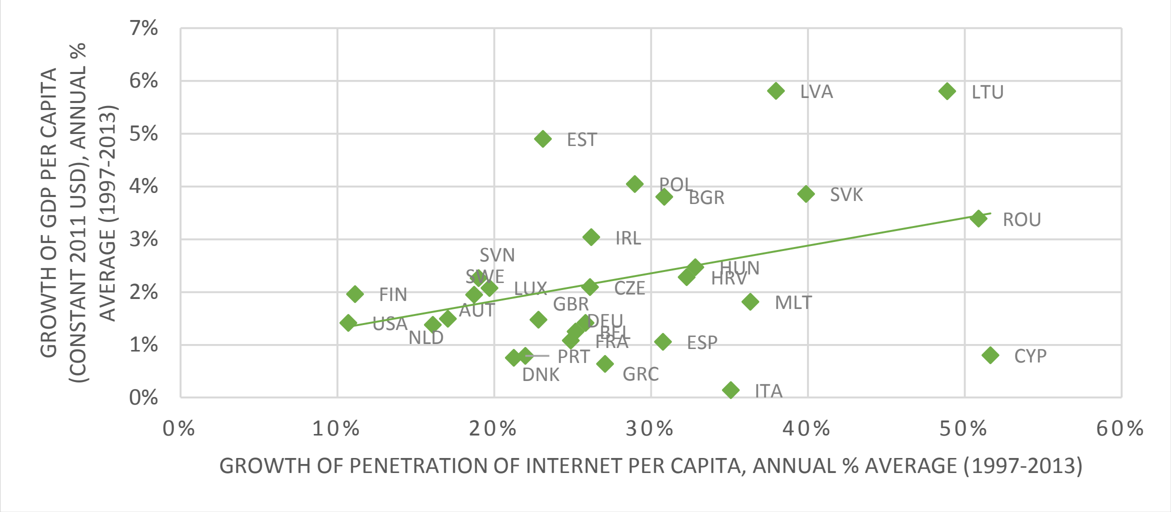
Figure 6: Growth of penetration of mobile phones versus GDP growth (1997-2013)



Source: own computations, using the data from WDI

Also the second indicator of ICT competitiveness – internet penetration – is relatively highly correlated with GDP per capita growth, as can be seen in *Figure 7*. As with the case of R&D expenditure, it is evident that slope of the trend line has a downward bias due to inclusion of GIPS countries (and Cyprus), where positive effect from ICT diffusion has been overshadowed by the growth stagnation / decline after the financial and during the debt crisis; for instance, the graph shows that even rapid increase in availability of ICT technologies in Cyprus was not a sufficient impulse to boost economic growth in the country. Similarly, internet penetration in Italy has grown by approximately the same average rate per year (or even faster) than several transitional economies, but recorded the lowest average growth per capita in EU over the sample period. Overall, the evidence suggests that broadening of ICT infrastructure played a significant role in promoting growth in the transitional economies.

Figure 7: Growth of penetration of internet versus GDP growth (1997-2013)

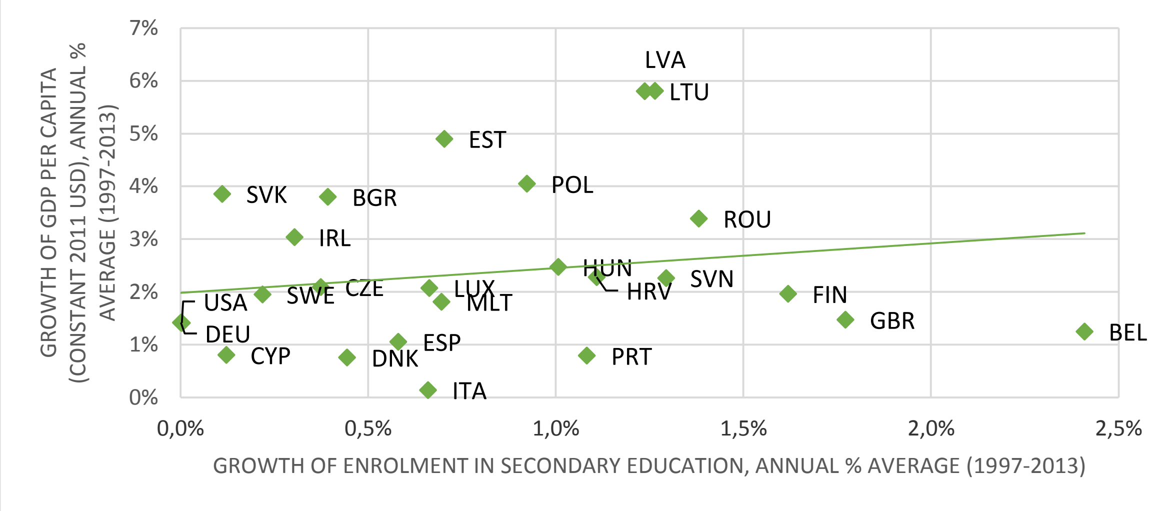


Source: own computations, using the data from WDI

Education competitiveness

Figure 8 plots the growth of GDP per capita against growth in secondary education enrolment. The XY plot suggests that secondary education enrolment per se is not a reliable indicator of human capital development in our sample of countries; for instance, Slovakia and Bulgaria are among the fastest growing economies in EU, but school attainment in these countries has grown at a below-average pace. Similarly, Estonia, which recorded the third highest average growth rate in EU over the sample period, experienced growth in secondary education enrolment only at the rate approximately equal to sample average. Therefore, the use of this indicator in Fagerberg, Srholec and Knell (2007) may be justified, as it is not the only proxy for education, but rather one of the components in the *Capacity* composite indicator; however the indicator by itself most probably does not reflect the growth of human capital sufficiently. Greece was excluded from the plot due to excessive number of missing observations.

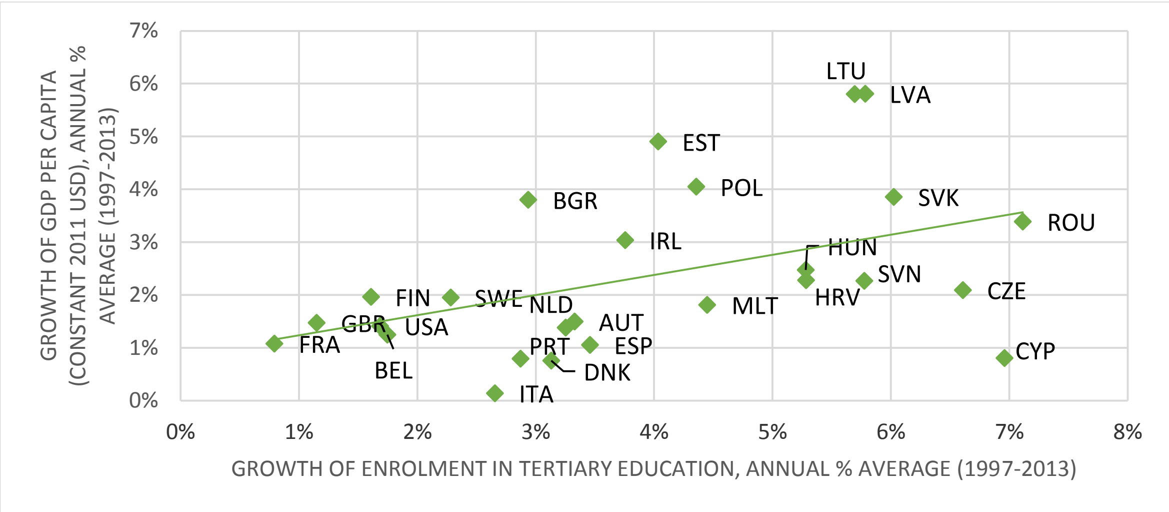
Figure 8: Growth of enrolment in secondary education versus GDP growth (1997-2013)



Source: own computations, using the data from WDI

Enrolment in tertiary education, on the other hand, shows a significant positive effect on growth, which is, to some extent, distorted by the inclusion of the GIPS countries again (except for Greece, which is not included due to data issues, together with Germany and Luxembourg), as illustrated in *Figure 9*. Consistent with the theory of endogenous growth, increase in human capital stock, as proxied by tertiary school attainment, seems to have been one of the driving forces of growth in EU.

Figure 9: Growth of enrolment in tertiary education versus GDP growth (1997-2013)

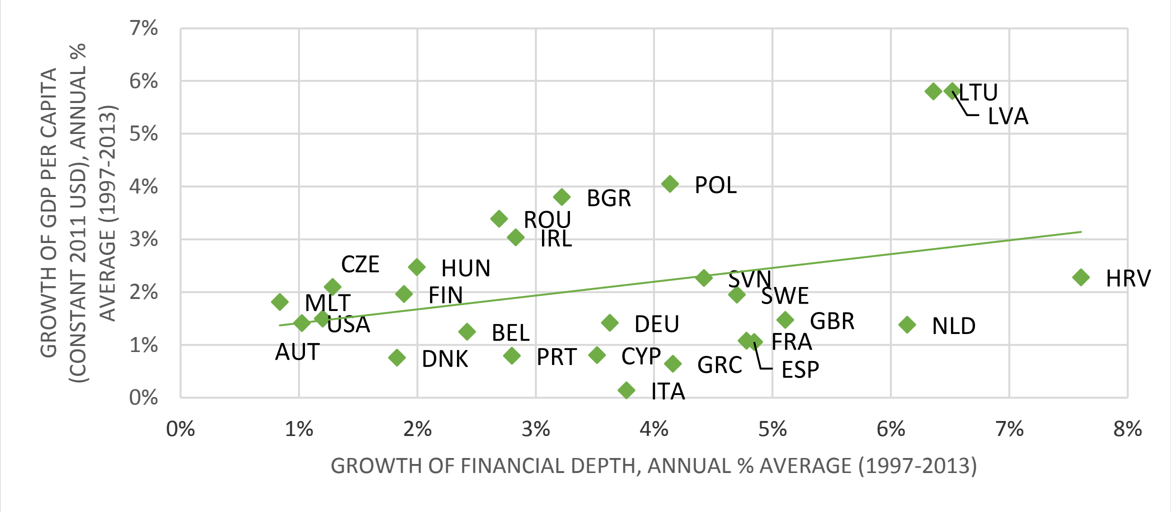


Source: own computations, using the data from WDI

Finance comptetitiveness

The indicators to represent financial development in our framework are relative size of financial sector (financial depth, to be exact) and domestic credit to private sector. The former is plotted against GDP per capita growth in *Figure 10*. The correlation between these indicators is relatively weak; it is caused by the fact that size of financial sector has in many cases increased at higher rate in advanced economies (e.g. Sweden, the United Kingdom, France, Netherlands, etc.) than in the transitional countries with markedly higher growth rates (e.g. Poland, Bulgaria, Romania, etc.). Estonia, Luxembourg and Slovakia were excluded due to missing data.

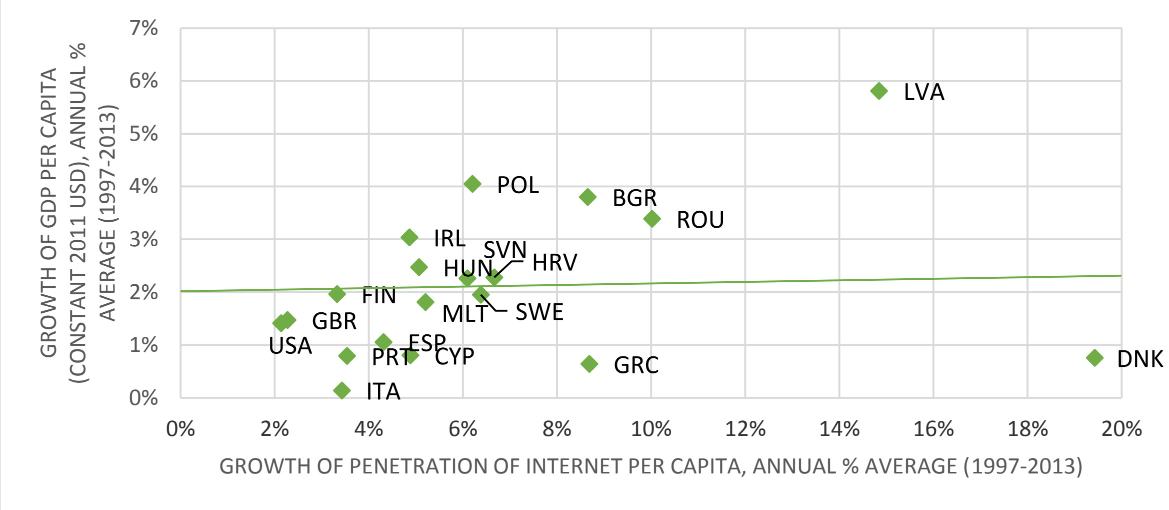
Figure 10: Growth of financial depth versus GDP growth (1997-2013)



Source: own computations, using the data from Global Financial Development database

Figure 11 visualizes the relationship between domestic credit to private sector and GDP per capita growth. As was the case with the previous measure, there is no clear causality between the indicators. However, the result might not reflect the real situation as six mostly advanced countries were excluded from the analysis due to data issues (namely: Austria, Belgium, France, Lithuania, Luxembourg, and Netherlands). Moreover Denmark stands out in this matter, with growth of domestic credit growing on average almost twice as high as in Romania, whose credit grew at the third highest average rate; as a result, the slope is biased downward.

Figure 11: Growth of domestic credit to private sector versus GDP growth (1997-2013)

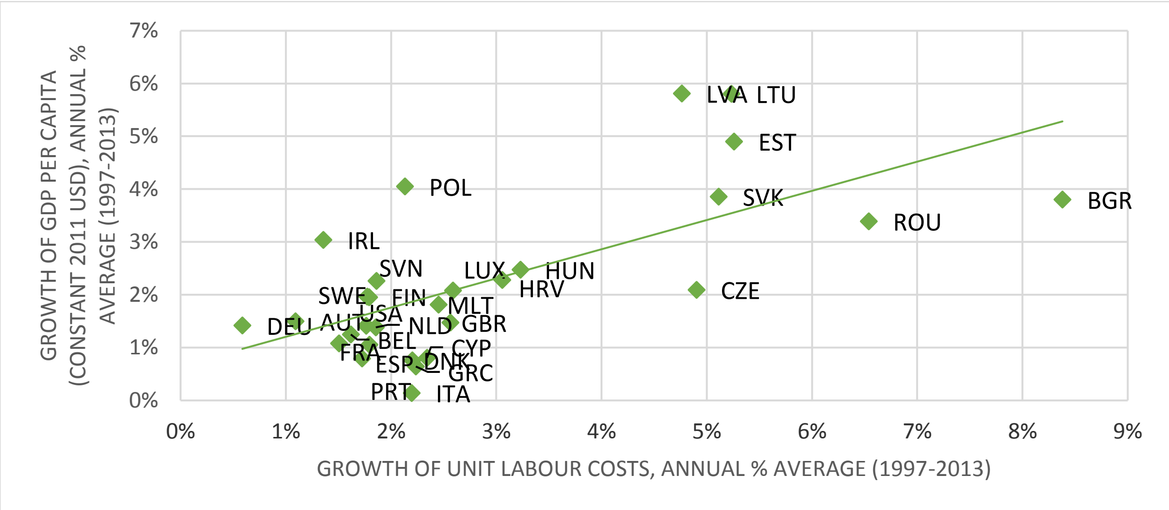


Source: own computations, using the data from Knoema

Price competitiveness

The relationship between unit labour costs, as a proxy for price competitiveness, and growth of GDP per capita is plotted in *Figure 12*. The plot shows some support to Kaldor's paradox (1978), as the countries which have grown the most are also among the ones where the labour costs rose at the highest rate (i.e. transitional economies), which is in contradiction with the theory which predicts the relationship to be inverse. Poland may have been an exception, as despite its high GDP per capita growth rate, its unit labour costs were growing at a below-average rate.

Figure 12: Growth of unit labour costs versus GDP growth (1997-2013)

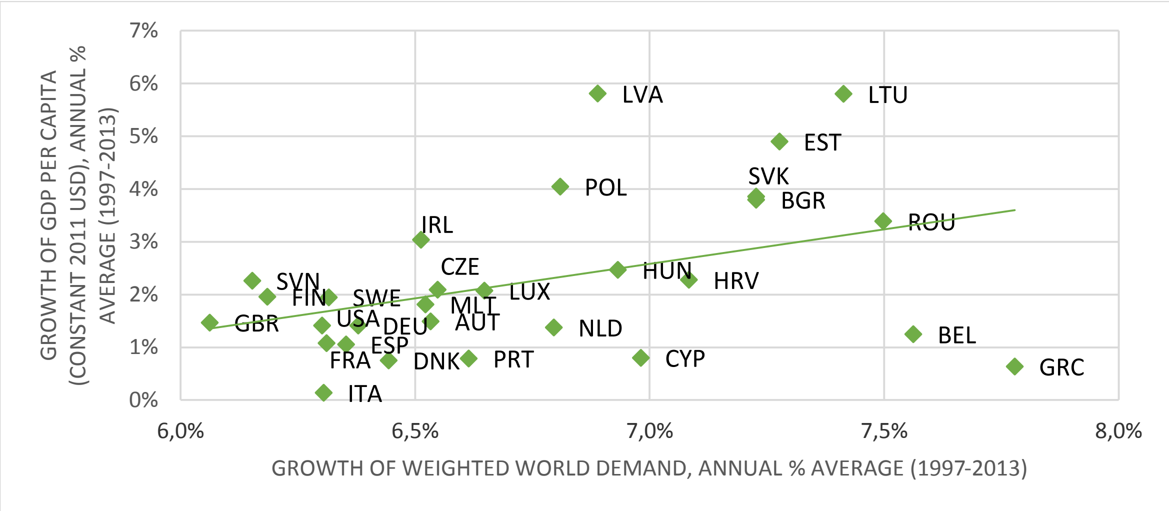


Source: own computations, using the data from Eurostat

Demand competitiveness

Demand competitiveness is proxied by a weighted world demand, where weights are represented by countries‘ export specialization in different types of products. *Figure 13* plots the relationship between this indicator (whose calculation is explained in the *„Data and methodology“* section) and GDP per capita growth. There seems to be a link between these indicators, as the transitional economies are again amongst the countries with the most improving demand conditions. Conversely, inclusion of Greece (and other GIPS countries) biases the slope downward again, as the country could not achieve higher average per capita growth even despite increasingly favourable composition of exports; more precisely, the demand conditions in Greece have improved the most over the period, as the XY plot suggests, but the fact was not reflected in growth.

Figure 13: Growth of weighted world demand versus GDP growth (1997-2013)

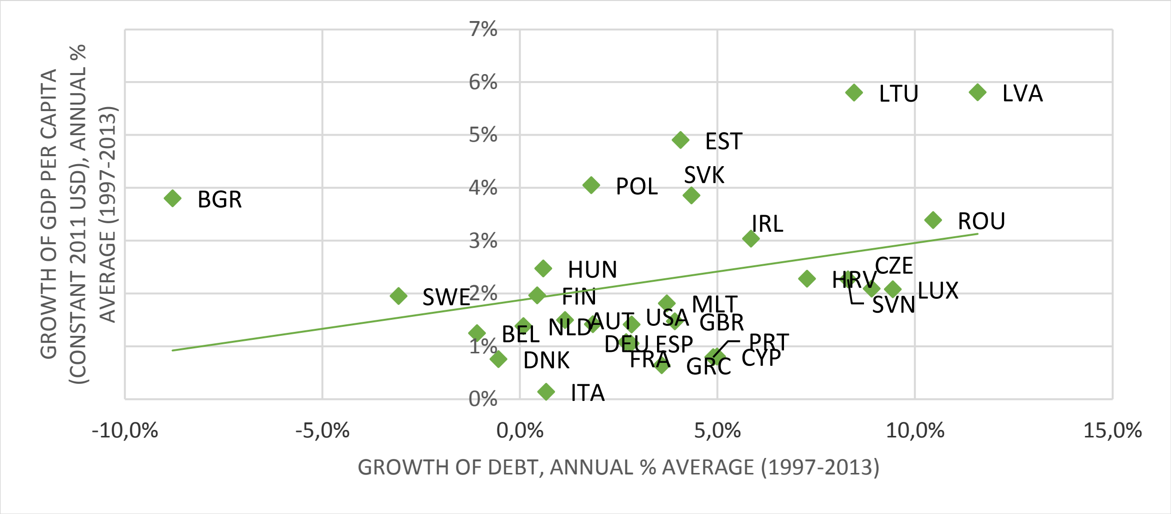


Source: own computations, using the data from UNCTADstat

Debt-growth relationship

Figure 14 plots growth of government debt against GDP per capita growth. There are several peculiarities in the plot. Firstly, it is clear that transitional economies have, in general, increasingly accumulated debt over the period, except for Bulgaria, which has on average decreased its debt (so has Belgium, Denmark, and Sweden). Secondly, their debts grew at a faster average rate than those in the GIPS countries, which is due to already high initial levels of debt in these countries. Thirdly, focusing solely on transitional economies, the plot provides mixed results. For instance, Croatia, Czech republic and Slovenia accumulated debt at a rate similar to that of Lithuania, but achieved a much lower average GDP per capita growth; at the same time, countries such as Estonia, Poland and Slovakia accumulated debt at considerably slower rates, but have also significantly outperformed the previosly mentioned group in terms of GDP per capita growth. Therefore it seems that the result might not be robust to changes in the composition of our sample of countries.

Figure 14: Growth of debt versus GDP growth (1997-2013)



Source: own computations, using the data from UNCTADstat

V. Results from the econometric model

Combining the proxies for six of our seven aspects of competitiveness (exluding debt) resulted in creation of 16 different model specifications. The results from pooled OLS regressions and Fixed effects regressions on the sample of EU-28 countries are summarized in *Appendix B and C*, respectively.

Several findings are worth mentioning. First of all, Fixed effects regression does not change the outcome of pooled OLS dramatically; each of the variables that are significant in OLS remain significant in FE, and vice versa. However, it does considerably increase the R^2. Secondly, the results confirm what was already evident from the XY plots in the previous section that, contradictorily to Fagerberg (1987), R&D spending and patent-based variables are not necessarily correlated. In our case, while R&D expenditure is statistically insignificant in each of the 8 specifications it is involved in, the opposite is true in the case of EPO patents granted (i.e. very high statistical significance in most specifications). Therefore, specifications including R&D expenditure as a standalone proxy for technological competitiveness would be in strong contradiction with modern empirical literature, where technological progress is a key driver of growth (e.g. Romer, 1990; Grossman and Helpman, 1991; and others), despite the fact that these specifications had a marginally higher R^2 than the specifications including patents instead. The same applies to proxies for education competitiveness. As expected, enrolment in secondary education turned out to be a poor predictor of economic growth, whereas tertiary education enrolment is consistently and highly significant.

Proxies of ICT infrastructure penetration show, consistently with ICT-growth-related literature (e.g. Seo, Lee and Oh, 2009), very high statistical significance in predicting economic growth. Moreover, their magnitude, as well as the resulting R^2 of the models they were included in, are very similar. Penetration of mobile phones will be used in further analysis due to marginally higher average R^2.

Regarding the financial development competitiveness, both variables chosen as proxies were statistically insignificant in every specification, which is consistent with studies by Ram (1999) and Favarra (2003), as they found only weak linkage between financial development and growth on their samples as well. What is interesting is that the coefficients had, overall, opposite signs for the two indicators; increasing size of financial sector seems to affect (although only weakly) growth negatively, while increasing credit availability has a marginal positive impact on growth. Inclusion of the indicator of domestic credit to private sector led, in general, to higher R^2, therefore will be prioritized in the next model modifications.

Unlike in the XY plot discussed in the previous section, where price competitiveness, as proxied by unit labour costs, indicated high correlation with growth, inclusion of other factors caused its statistical insignificance in all specifications (Fagerberg, Srholec and Knell, 2007, also found this factor to be relatively unimportant). However, contradictorily to what theory predicts and consistently with Kaldor's paradox (1978), sign of the coefficient remains positive in the vast majority of specifications.

Finally, the link between world demand and growth turned out to be surprisingly strong, as the results suggest that this aspect of competitiveness affects economic growth with the highest magnitude of all. Therefore, favourable demand conditions seem to have contributed to growth of transitional countries to the greatest extent.

To summarize the arguments above, we can rewrite the chosen model specification as follows:

$$d\_l\_GDPpc_{i,t} = a_0 + a_1\, l\_GDPpc\_i_{i,t} + a_2\, d\_l\_Pat_{i,t} + a_3\, d\_l\_Mob_{i,t} + a_4\, d\_l\_Enrter_{i,t} + a_5\, d\_l\_Credit_{i,t} + a_6\, d\_l\_ULC_{i,t} + a_7\, d\_l\_Demand_{i,t} + \varepsilon_i, \quad (6)$$

where $Pat_{i,t}$ is number of EPO patents granted of country *i* in time *t*, *Mob* is penetration of mobile phones, *Enrter* is enrolment in tertiary education, *Credit* is domestic credit to private sector, *ULC* are unit labour costs, and *Demand* is weighted world demand.

The role of debt

In the next step, we extend our framework by the indicator of government debt, which we expect to vastly affect the outcome of the model. We do so by adding this variable to the specification stated in equation number (6), therefore the modified equation is as follows:

$$d\_l\_\ GDPpc_{i,t} = a_0 + a_1\ GDPpc\_i_{i,t} + a_2\ d\_l\_Pat_{i,t} + a_3\ d\_l\_Mob_{i,t} + a_4\ d\_l\_Enrter_{i,t} + a_5\ d\_l\_Credit_{i,t} + a_6\ d\_l\_ULC_{i,t} + a_7\ d\_l\_Demand_{i,t} + a_8\ d\_l\_Debt_{i,t} + \varepsilon_i, \quad (7)$$

where $Debt_{i,t}$ is government debt of country *i* in time *t*.

The results of the pooled OLS regression and Fixed effects regression are presented in **Table 1**.

Table 1: Pooled OLS and Fixed effects regression results, without and including debt, sample of EU-28 countries; 1997-2013

	Dependent variable: d_l_GDPpc							
	Without debt				*Including debt*			
	Pooled OLS		***FE***		***Pooled OLS***		***FE***	
const	0,2327 (6,73)	***	0,0038 (1,47)		0,2677 (9,73)	***	0,0160 (7,76)	***
d_l_GDPpc_i	-0,0231 (-6,75)	***			-0,0256 (-9,41)	***		
d_l_Pat	0,0097 (2,51)	**	0,0088 (2,31)	**	0,0051 (1,66)	*	0,0027 (0,93)	
d_l_Enrter	0,0891 (3,30)	***	0,0957 (3,44)	***	0,0727 (3,40)	***	0,0545 (2,60)	***
d_l_Mob	0,0170 (3,08)	***	0,0191 (3,46)	***	0,0130 (2,91)	***	0,0128 (3,00)	***
d_l_Credit	0,0041 (1,05)		0,0035 (0,92)		-0,0010 (-0,31)		-0,0012 (-0,38)	
d_l_ULC	0,0024 (0,09)		0,0019 (0,07)		-0,0397 (-1,96)	*	-0,0422 (-2,20)	**
d_l_Demand	0,1736 (12,70)	***	0,1722 (12,81)	***	0,1138 (9,83)	***	0,1060 (9,72)	***
d_l_Debt					-0,1435 (-14,14)	***	-0,1584 (-15,51)	***
R-squared	**0,4509**		**0,5158**		**0,6665**		**0,7377**	
Observations	339		339		331		331	

Source: calculated using Gretl; Note: t-statistic is in parentheses; *** significant at 1%, ** significant at 5%, * significant at 10%

As the results suggest, there is a strong negative relationship between government debt and output per capita growth, which is in line with Kumar and Woo (2010). The result, however, may have been driven by the GIIPS country group with excessive post-crisis debts approaching (or exceeding) the 100% threshold as illustrated in the previous section. We will sort the countries into different groups in the posterior part of the study to check the robustness of the result.

Inclusion of debt in the model had a number of significant effects on coefficients of other variables. First of all, patents coefficient is only significant at 10%, instead of 5% in „no-debt" specification in pooled OLS, and even loses statistical significance in FE. Coefficients of other variables have decreased as well, and even turn negative in the case of unit labour costs and domestic credit to private sector (where the former becomes statistically significant at 10% and 5% for pooled OLS and FE, respectively). Moreover, including debt has considerably increased the R^2 of the model.

Table 1 also allows us to compare the changes in magnitude of individual variables in the model based on whether we use a basic pooled OLS, or Fixed effects regression. Without debt, FE increases the magnitude of tertiary education enrolment and mobile-phone penetration, while decreasing the magnitude of patents and marginally also world demand. In the specification including debt, FE decreases coefficient of all variables, including debt.

Robustness tests

In this subsection we will split the full sample of EU-28 member states into several country groups to see how different characteristics of these groups affect the outcome of the regression. The groups are composed with respect to two criteria: initial stage of development (advanced represented by EU-15 and developing by transitional economies[6]), and the impact of debt crisis (separation or exclusion of GIPS countries). We only compare results from Fixed effects regressions in order to preserve the clarity of presented results. *Table 2* presents regression results for five country groups, namely EU-15, transitional economies, GIPS group, EU-28 without the GIPS countries, and EU-28 to allow for comparison with previous results.

[6] Transitional economies in our sample include: Bulgaria, Croatia, Czech republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, and Slovenia.

Table 2: FE regression results, 4 groups of countries; 1997-2013

Dependent variable: d_l_GDPpc										
Country group	***EU-28***		***EU-15***		***Transitional***		***GIPS***		***EU-28 minus GIPS***	
const	0,0160	***	0,0033		0,0258	***	0,0127		0,0173	***
	(7,76)		(1,27)		(7,03)		(1,22)		(8,00)	
d_l_Pat	0,0027		0,0011		0,0018		-0,0032		0,0027	
	(0,93)		(0,14)		(0,49)		(-0,22)		(0,93)	
d_l_Enrter	0,0545	***	0,0613	**	0,0680	**	0,1353		0,0567	***
	(2,60)		(2,04)		(2,06)		(1,47)		(2,64)	
d_l_Mob	0,0128	***	0,0378	***	0,0082		0,0188		0,0114	***
	(3,00)		(4,29)		(1,49)		(1,03)		(2,61)	
d_l_Credit	-0,0012		-0,0081		0,0001		-0,0194		-0,0008	
	(-0,38)		(-0,67)		(0,02)		(-0,23)		(-0,26)	
d_l_ULC	-0,0422	**	-0,0472		-0,0408	*	-0,1801		-0,0407	**
	(-2,20)		(-1,29)		(-1,66)		(-1,36)		(-2,11)	
d_l_Demand	0,1060	***	0,0889	***	0,1389	***	0,0000		0,1200	***
	(9,72)		(7,39)		(7,31)		0,00		(10,28)	
d_l_Debt	-0,1584	***	-0,1400	***	-0,1537	***	-0,2663	***	-0,1526	***
	(-15,51)		(-9,11)		(-10,27)		(-4,57)		(-14,69)	
R-squared	**0,7377**		**0,7178**		**0,7301**		**0,6327**		**0,7530**	
Observations	331		158		160		46		285	

Source: calculated using GRETL; Note: t-statistic is in parentheses; *** significant at 1%, ** significant at 5%, * significant at 10%

There are a few noticeable distinctions between advanced and transitional European countries regarding the importance of different aspects of competitiveness. First of all, ICT competitiveness turns out to be more important in the case of advanced economies, whereas in the case of transitional economies, the factor is statistically insignificant. Secondly, even though demand competitiveness is strongly statistically significant in both groups, favourable demand conditions seem to be of much higher importance in the transitional economies than in the advanced ones. Further, our calculations suggest that increasing unit labour costs affected growth negatively at 10% significance level in transitional economies, whereas price competitiveness was insignificant in EU-15. Finally, while Lithuania and Latvia recorded the highest average rate of growth over the sample period while at the same time accumulating debt at above-average rates, overall, debt affected growth with negative sign and with higher magnitude in transitional economies, even despite the fact that EU-15 includes the GIPS countries.

FE model on the sample of four GIPS countries provides markedly different results. The only factor that is significant in predicting growth of this country group is debt, with nearly double the magnitude of the EU-15 as a whole. On the other hand, while demand has been one of the most important factors of promoting growth in transitional economies, its impact on growth in GIPS has been negligible.

VI. Concluding remarks

The primary purpose of writing this paper was to find which factors have contributed to growth on the sample of the current European Union member states (EU-28). We found evidence that especially transitional European economies have largely benefited from favourable demand for their exported goods, as well as improving human capital base, where increase in tertiary school attainment played an important role in accelerating growth in these countries. Not taking government debt into account, R&D advance shows a positive and significant impact on growth in the sample, however significance of the factor disappears once we account for debt. It is, however, possible that EPO patents granted as a proxy for R&D are not an accurate representation of actual innovative activity of the countries (as the EPO patent activity has actually declined over time in many sample countries). Second possibility is that that are omitted variables which would boost the significance of the variable in the specifications including debt.

Inclusion of debt, as another aspect of competitiveness, in our framework is one of the main contributions of the paper, as the indicator is not present in the model by Fagerberg, Srholec and Knell (2007), which our model loosely built on. Inclusion of the variable was motivated by debt crisis in the EU and to assess the extent to which this event affected growth in certain country groups, especially GIPS countries. We found the factor to significantly affect growth with negative sign in all country groups; the negative impact of rising debt seems to have been stronger in transitional than in advanced economies, but the notable finding is that on the sample of GIPS countries, it was the only significant indicator.

The paper also shows that while the countries that were hit by the debt crisis the most could not take advantage of favourable position in certain aspects of competitiveness (such as Greece with favourable demand conditions; or Cyprus with improving human capital, investment in technological progress, ICT and other areas), which supports the need for structural changes in EU (as suggested by e.g. Bordo, Markiewitz and Jonung, 2011; Lane, 2012; and De Grauwe, 2013) to prevent similar occurences in the future and to promote consistent reduction of the output-per-capita gap behind the U.S.

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Appendix A: Data sources

Table 3: Data definition and sources

Indicator	***Description***	***Database***
R&D expenditure	% of GDP	World Development Indicators
EPO patents granted	number of patents per capita (inventor's country of residence)	OECD patent databases, WDI (total population)
Enrolment in secondary education	% of people in secondary schooling age	World Development Indicators
Enrolment in tertiary education	% of people in tertiary schooling age	World Development Indicators
Penetration of mobile phones	number of mobile phones per 100 people	World Development Indicators
Penetration of internet	number of internet users per 100 people	World Development Indicators
Financial depth	liquid liabilities (M3 aggregate) as a % of GDP	Global Financial Development
Domestic credit to private sector	% of GDP	Knoema
Nominal unit labour costs	total labour costs per employee as a % of GDP per person employed	Eurostat
Exports	thousands of USD	UNCTADstat

Appendix B

Table 4: Pooled OLS regression results, 16 specifications, sample of EU-28 countries; 1997-2013

Dependent variable: d_l_GDPpc								
Specification	***1***		***2***		***3***		***4***	
const	0,1878	***	0,1640	***	0,1814	***	0,1579	***
d_l_GDPpc_i	-0,0186	***	-0,0160	***	-0,0183	***	-0,0157	***
d_l_RD	0,0067				0,0141			
d_l_Pat			0,0115	***			0,0120	***
d_l_Enrsec	0,0176		0,0209					
d_l_Enrter					0,0995	***	0,0918	***
d_l_Mob	0,0311	***	0,0279	***	0,0270	***	0,0243	***
d_l_Int								
d_l_Depth	-0,0022		-0,0037		-0,0034		-0,0045	
d_l_Credit								
d_l_ULC	0,0300		0,0314		0,0283		0,0302	
d_l_Demand	0,1798	***	0,1758	***	0,1770	***	0,1742	***
R-squared	**0,4277**		**0,4250**		**0,4530**		**0,4499**	
Observations	344		372		328		356	
	5		***6***		***7***		***8***	
const	0,1995	***	0,1805	***	0,1931	***	0,1742	***
d_l_GDPpc_i	-0,0198	***	-0,0177	***	-0,0195	***	-0,0173	***
d_l_RD	0,0056				0,0126			
d_l_Pat			0,0120	***			0,0125	***
d_l_Enrsec	0,0193		0,0217					
d_l_Enrter					0,0988	***	0,0913	***
d_l_Mob								
d_l_Int	0,0388	***	0,0306	***	0,0339	***	0,0266	***
d_l_Depth	-0,0072		-0,0093		-0,0079		-0,0096	
d_l_Credit								
d_l_ULC	0,0215		0,0256		0,0206		0,0251	
d_l_Demand	0,1784	***	0,1738	***	0,1756	***	0,1723	***
R-squared	**0,4292**		**0,4224**		**0,4546**		**0,4477**	
Observations	344		372		328		356	
	9		***10***		***11***		***12***	
const	0,2634	***	0,2260	***	0,2704	***	0,2327	***
d_l_GDPpc_i	-0,0260	***	-0,0221	***	-0,0270	***	-0,0231	***
d_l_RD	-0,0061				0,0018			
d_l_Pat			0,0095	**			0,0097	**
d_l_Enrsec	0,0039		0,0084					
d_l_Enrter					0,0880	***	0,0891	***
d_l_Mob	0,0190	***	0,0192	***	0,0152	***	0,0170	***
d_l_Int								
d_l_Depth								
d_l_Credit	0,0039		0,0039		0,0032		0,0041	
d_l_ULC	-0,0003		0,0018		0,0005		0,0024	
d_l_Demand	0,1785	***	0,1754	***	0,1755	***	0,1736	***
R-squared	**0,4417**		**0,4280**		**0,4657**		**0,4509**	
Observations	323		350		310		339	

	13		14		15		16	
const	0,2684	***	0,2382	***	0,2753	***	0,2455	***
d_l_GDPpc_i	-0,0266	***	-0,0234	***	-0,0277	***	-0,0244	***
d_l_RD	0,0000				0,0063			
d_l_Pat			0,0092	**			0,0096	**
d_l_Enrsec	0,0037		0,0093					
d_l_Enrter					0,0870	***	0,0889	***
d_l_Mob								
d_l_Int	0,0265	***	0,0225	***	0,0217	***	0,0192	***
d_l_Depth								
d_l_Credit	0,0030		0,0032		0,0025		0,0035	
d_l_ULC	-0,0032		-0,0001		-0,0022		0,0007	
d_l_Demand	0,1784	***	0,1749	***	0,1753	***	0,1729	***
R-squared	**0,4431**		**0,4268**		**0,4671**		**0,4489**	
Observations	323		350		310		339	

Source: calculated using GRETL; Note: *** significant at 1%, ** significant at 5%, * significant at 10%

Explanatory notes: *GDPpc_i* = initial GDP per capita; *RD* = R&D expenditure; *Pat* = patents granted; *Enrsec, Enrter* = education enrolment (secondary and tertiary, respectively); *Mob* = mobile phones; *Int* = internet; *Depth* = financial depth; *Credit* = domestic credit to private sector; and *ULC* = unit labour costs.

Appendix C

Table 5: Fixed effects regression results, 16 specifications, sample of EU-28 countries; 1997-2013

Dependent variable: d_l_GDPpc								
Specification	***1***		***2***		***3***		***4***	
const	0,0027		0,0042	*	-0,0006		0,0016	
d_l_RD	0,0122				0,0237			
d_l_Pat			0,0119	***			0,0123	***
d_l_Enrsec	0,0233		0,0299					
d_l_Enrter					0,1187	***	0,0961	***
d_l_Mob	0,0323	***	0,0305	***	0,0272	***	0,0265	***
d_l_Int								
d_l_Depth	-0,0022		-0,0072		-0,0072		-0,0052	
d_l_Credit								
d_l_ULC	0,0330		0,0349		0,0325		0,0361	
d_l_Demand	0,1835	***	0,1766	***	0,1812	***	0,1758	***
R-squared	**0,4838**		**0,4789**		**0,5113**		**0,5018**	
Observations	344		372		328		356	
	5		***6***		***7***		***8***	
const	0,0015		0,0041		-0,0017		0,0014	
d_l_RD	0,0134				0,0245			
d_l_Pat			0,0123	***			0,0128	***
d_l_Enrsec	0,0293		0,0319					
d_l_Enrter					0,1186	***	0,0973	***
d_l_Mob								
d_l_Int	0,0411	***	0,0332	***	0,0353	***	0,0290	***
d_l_Depth	-0,0104		-0,0101		-0,0107		-0,0093	
d_l_Credit								
d_l_ULC	0,0221		0,0283		0,0222		0,0296	
d_l_Demand	0,1824	***	0,1745	***	0,1802	***	0,1741	***
R-squared	**0,4858**		**0,4744**		**0,5132**		**0,4984**	
Observations	344		372		328		356	
	9		***10***		***11***		***12***	
const	0,0061	**	0,0067	***	0,0027		0,0038	
d_l_RD	-0,0032				0,0073			
d_l_Pat			0,0083	**			0,0088	**
d_l_Enrsec	0,0107		0,0179					
d_l_Enrter					0,1094	***	0,0957	***
d_l_Mob	0,0197	***	0,0209	***	0,0157	***	0,0191	***
d_l_Int								
d_l_Depth								
d_l_Credit	0,0031		0,0032		0,0024		0,0035	
d_l_ULC	-0,0053		-0,0024		-0,0009		0,0019	
d_l_Demand	0,1787	***	0,1726	***	0,1767	***	0,1722	***
R-squared	**0,5103**		**0,4946**		**0,5333**		**0,5158**	
Observations	323		350		310		339	

	13		14		15		16	
const	0,0044		0,0060	**	0,0013		0,0034	
d_l_RD	0,0056				0,0141			
d_l_Pat			0,0079	**			0,0086	**
d_l_Enrsec	0,0130		0,0192					
d_l_Enrter					0,1090	***	0,0959	***
d_l_Mob								
d_l_Int	0,0287	***	0,0247	***	0,0237	***	0,0219	***
d_l_Depth								
d_l_Credit	0,0022		0,0024		0,0017		0,0029	
d_l_ULC	-0,0097		-0,0049		-0,0051		-0,0006	
d_l_Demand	0,1791	***	0,1723	***	0,1769	***	0,1717	***
R-squared	**0,5135**		**0,4937**		**0,5359**		**0,5137**	
Observations	323		350		310		339	

Source: calculated using GRETL; Note: *** significant at 1%, ** significant at 5%, * significant at 10%

Explanatory notes: *RD* = R&D expenditure; *Pat* = patents granted; *Enrsec*, *Enrter* = education enrolment (secondary and tertiary, respectively); *Mob* = mobile phones; *Int* = internet; *Depth* = financial depth; *Credit* = domestic credit to private sector; and *ULC* = unit labour costs.