The Global Competitiveness Index: Should Countries Strive for a Higher Score?

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Abstract

Several indices exist to assess country level economic performance, among them the Global Competitiveness Index enjoys the greatest popularity. Politicians, policymakers, businesses regard it as an important point of reference in determining country competitiveness. At the same time, studies committing to formally establish the nature of its relationship with the actual competitiveness of countries are few and far between. It may well be, that the purpose of the Global Competitiveness Index is to give insights about the long-term factors of competitiveness, the measuring of these associations is limited by the availability of data. As a consequence, this paper aims at unveiling the relationship of changes in the scores of index and short term productivity growth. For the analysis, both panel and cross section data are used covering in the broadest sample ten years and 121 countries. The results suggest an association between the changes of the index scores and the productivity proxy, GDP per capita growth, all while discounting the effect of beta convergence. These findings remain significant when using gross value added per capita as an alternative productivity measure, but the association is not straightforward when substituting the index with its components.

Keywords: Global Competitiveness Index; productivity growth, panel data, beta convergence

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Chapter 1 Introduction

Country competitiveness has always been in the forefront of policy and political discussions, no wonder why serious efforts are taken to quantify and measure it. There are multiple indices and reports of competitiveness, the Global Competitiveness Report, issued by the World Economic Forum is the most widely used. The yearly publication of the documents attracts a great deal of attention, even small changes in the ranking or the pertaining score do not tend to go unnoticed. Still the question arises, what are the actual implications of the index score on country competitiveness?

So far, there was only a few research which covered this topic (Kordalska - Olczyk 2016, Carvalho et al. 2012), with varying conclusions. Mostly it is found that the index suffers from certain insufficiencies, which may be due to its structure. The link between productivity and the index has been shown, but the inverse relationship is less straightforward to demonstrate. The following piece of research takes on this task and aims to uncover the index's power with respect to a nation's productivity. The main question is does the index help make inferences on GDP per capita growth on the short term?

The thesis is organized as follows. Chapter 2 describes the two theoretical frameworks which supports the analysis of the relationship between productivity growth and the Global Competitiveness Index. These are applied because they add depth methodology and help understanding the underlying mechanisms of the association. Chapter 3 describes extensively the Global Competitiveness Index and its relationship with these frameworks. This part already contains some indications on the methodology and reasoning on the choice of variables. Next follows the analysis with using predominantly panel data to be able to infer both contemporaneous relationships and to see how the current level of the Global Competitiveness Index inform us on subsequent productivity changes. For this, first differences, fixed effects and long differences are applied. Chapter 5 contains the discussions of the results and finally Chapter 6 concludes and extends on the policy implications.

Chapter 2 Literature review

There are two underlying theories which has guided this particular piece of research on the of growth and the Global Competitiveness Index. One of them is beta convergence (Sala-Martin, Barro,1992) and the other one is factor model of growth by Porter (Acs et al. 2008) First, these theories shall be shortly discussed before turning to the index the index and its implications.

2.1 Beta convergence

Sala-i-Martin and Barro (1992) found that poor countries grow faster and are able to catch up to their more developed counterparts in terms of per capita income and product. This phenomenon was labeled as beta convergence. The annual rate of two percent of convergence of relatively poorer countries has become a stylized fact, although its accuracy is widely discussed. (Sala-i-Martin in Monfort, 2008). One of the popular views serving as an underlying rational for beta convergence is the theory of relative backwardness, which was first described by Alexander Gerschenkron (1962 cited in Fracasso -Vitucci, 2014). This theory states that economic growth of a poorer country is positively determined by its economic distance from the leader countries, in other words, more economically destitute countries bypass certain stages of development and become developed faster. The reason for this can be the underdeveloped countries can make use of -amongst others the technological inventions of more advanced countries (Samuelson-Nordhaus, 1992, p. 529)

An important distinction in terms of beta convergence is between conditional and unconditional convergence. Unconditional or absolute convergence posits that richer counties grow slower under all circumstances compared to their poor counterparts, and vice versa. According to Sala-i-Martin and Barro, this is captured by the ubiquitous 2% rate of convergence. However, in reality, a uniform rate of convergence cannot be observed across countries. The reason for that is the assumption of countries being in their steady state is not necessarily satisfied. (Próchniak – Witkowski, 2013). The theory of conditional convergence, nevertheless, is capable of accommodating the differences between the theory and real world observations, by adding further explanatory variable to the regression equation. This approximates the model closer to empirical findings of convergence. Experimenting with various set of explanatory variables were done by many researchers, using wide set of indicators which are thought to be capable creating an artificial the steady state. (Abreu et al.,2005). The Global Competitiveness Index due to its complex nature has the potential to fill the role of the explanatory variables, approximating the steady state, thus helps seeing the real catching up effect taking place for poor countries. However, for the purposes of this paper a different link between Global Competitiveness Index and beta convergence is described. The phenomenon of beta convergence is essential for the correct interpretation of the index. This statement will be elaborated further at the description of the Global Competitiveness Index itself.

2.2 Porter's three stages of growth for countries

The second theory is closely related with structure of the index. This framework for the development of countries was created by Michael Porter, transforming the work of Rostow on the five states of development (Schwab and Porter, 2008). Porter distinguishes three stages of growth: factor driven, efficiency or investment driven and innovation driven. (Acs et al. 2008). During the first stage, factor driven growth, countries rely on factor endowments, mostly natural resources. Firms benefit from these endowments to produce low value added basic goods. The competitiveness at this stage of the development hinges solely upon low input costs. Also, the role of the government is very articulate, responsible for providing basic services and institutions. (e.g.: primary education.)

When transitioning into the efficiency driven stage, with the improvement of product quality and gradual sophistication of processes, wages and prices rise. At this stage, nevertheless, no new technology is created inside a country, rather they are transferred by a variety of processes such as the inflow of foreign direct investment or international joint ventures. (Schwab, 2008) In terms of industries specificities, manufacturing is the most emphasized, and the economy is more vulnerable to sectoral demand shocks. At this stage, the efficient use of inputs and the nations proneness to invest are considered as the driving force of competitiveness. (Porter et al. 2004).

In the last stage, innovation drives competitiveness. Firms are already involved in the international or global competition, in an increasing fraction in niche market segments, with usually high value added products and services. (Acs et al. 2008). Prices have caught up to high wages and the increased standard of living (Schwab, 2015). In this stage, the economy is the most resilient vis-à-vis external demand shocks and exchange rate fluctuations, compared to its earlier periods of growth. (Porter et. al 2004) This is partly due to the globalized reach of firms which serves as a cushion in weathering these shocks. With the enlarging of the economy, thus direct government interventions represent an increasingly smaller role in the success of the economy. Since the government activity is not as important in driving further development, the innovative forces must originate from the private sector. (Porter, 2011)

This framework plays an important role in the composition of the index. It is revisited at the end of the literature review, developing more on its rule with respect to the design of the index.

Chapter 3 The Global Competitiveness Index

Before developing on the index, an important question arises: what is actually competitiveness of nations**?** There is a plethora of definitions for that. Some authors give a different definition: such as competition is the ability to produce goods and services which reach the benchmark set by other countries, while maintaining a standard of living in the country that is both growing and sustainable on the long term. (Krugman 1994) According to the Yearbook of IMD World Competitiveness Center, competitiveness is related to the ability of creating value added. (Kunova-Dolinsky, 2014) Porter however, one of the most prolific authors on the topic defines competitiveness solely on the basis of productivity. (Porter 1998, p.158) The mission stated by the Global Competitiveness report, published by the Swiss policy organization, the World Economic Forum is very much aligned with this, it states *"...providing insight into the drivers of their* [the nations] *productivity and prosperity".* (Schwab et al., 2015)

A crucial part of the Report, issued every year is the Global Competitiveness Index, which is a ranking published every year and gives information on the countries competitiveness with respect to other countries. The ranking is constructed based on country scores or the index which is the subject of the subsequent analysis. The number of countries covered is different each year, although by and large by enlarge it is steadily increasing. The last edition of the report, for 2016-2017 includes 138 countries. Although the first edition of the report was out as early as 1979 (Fendel -Frenkel, 2005), the Global Competitiveness Index has been around only since 2006. Its main function was to replace two very similar publications in nature, the Growth Competitiveness

Index, offering information on macroeconomic environment and the Business Competitiveness Index on microeconomic competitiveness (Porter-Delgado-Keterls-Stern, 2008). Since 2006, only the Global Competitiveness Index is issued. As stated by the Global Competitiveness Report (Scwab et al. 2006) the index's mission is to uncover the factors of long-term growth.

3.1 About the Index

The Global Competitiveness Index (in further discussions GCI or index), and the pertaining ranking covers a large number of countries (between approximately 100-150), which can slightly change year to year. Albeit mainly it is the ranking of countries which has the most exposition to the public and political leaders, the scores of the index, based on which the ranking is prepared each year which contains the information and can lend useful insight into a country's drivers of competitiveness. The structure of the index values is very complex and it is created by using various sources, a mixture of publicly available and other survey data. A considerable source, providing 79 out of the 113 sub indicators, is the Executive Operative Survey, which is created based on interviews with company leads and middle managers. (Balcarova, 2016). The indicators are grouped into twelve pillars, which are, in turn grouped into three large groups. The values are created using complex calculations, with a weighing system using both unfixed and stable weights. This enables the creation of a well-rounded indicator, which takes in consideration the differences amongst countries reflect the closest possible of the true picture of productivity of a nation.

3.2 Measuring productivity with GDP

In Porter's view (Porter, 1998) competitiveness of a nation solely hinges upon their productivity. However, to measure the productivity of a country, as a whole, is not straightforward undertaking. Although, there exists a methodology, pioneered by Solow (1957) which aims at calculating "total factor productivity". It is formally constructed as a quotient of output to input (which is capital and labor in the original equation). This is what`s labeled as the multifactor productivity index or residual that cannot be explained by neither capital nor labor. This is identified as technological progress by Nadiri. (1970) Still, the global competitiveness index‘s purpose to reflect, the level of productivity, of which this framework doesn’t give a complete picture about. (Schwab, 2015) In addition, according to Porter et all, the data on total factor productivity suffers from serial limitations, which constitute obstacles in their real-life usage. (Schwab – Porter, 2008)

Fortunately, however, the productivity can be well proxied by GDP per capita. Based on the finding of Hall and Jones (Hall and Jones, 1998 cited in Schwab, 2015) a considerable part of the variation of productivity can be explained by the variation of GDP. This serves as a proof to why GDP is the most adequate metrics to test the GCI against, should there be other measures of productivity, as well.

3.3 Relationship of GDP growth and the Competitiveness Index

When testing the relationship of the direction whether the Global Competitiveness Index truthfully reflects the GDP, Schwab and his co-authors find substantial evidence. This is described in the Global Competitiveness Report for 2014 – 2015. (Although, from the point of view of the research presented in this paper, this is not entirely sufficient, because the subject of interest is the reverse relationship, which is the Global Competitiveness Index effects on GDP growth.) Below is an important visual manifestation of the relationship, log values GDP per capita in 2013 and the edition of GCI in the subsequent year, the 2014-2015 Global Competitiveness Index. (Figure 1)

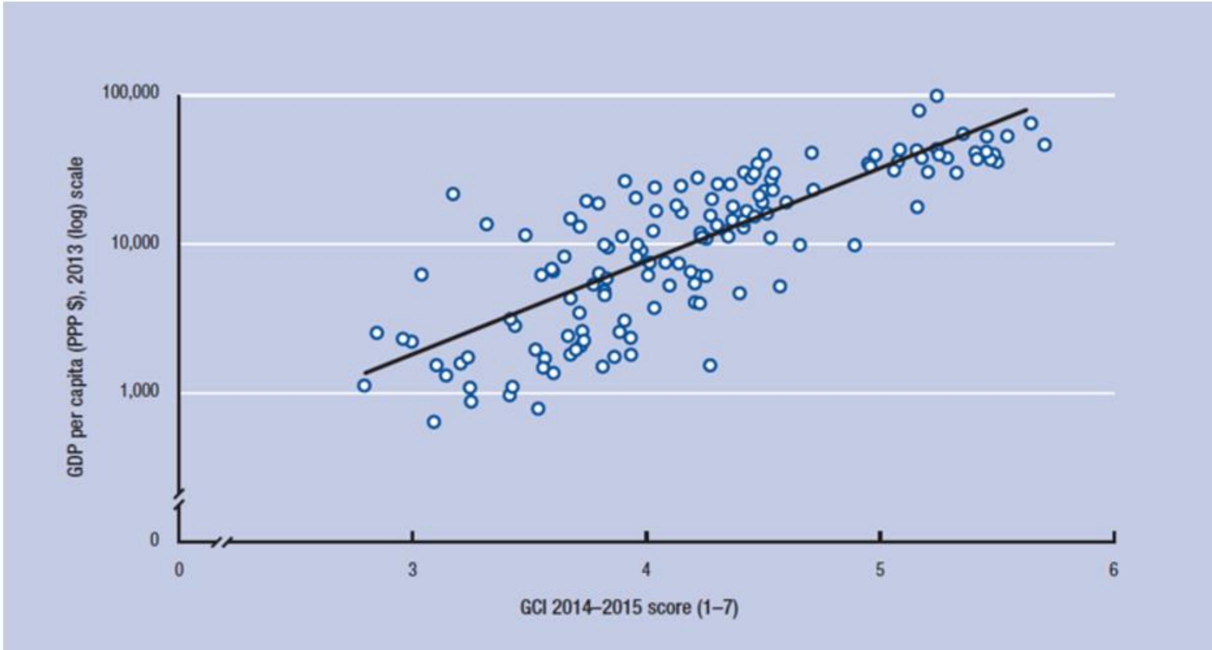

Figure 1 Relationship between the GCI and GDP per capita (143 country sample)
Source: Global Competitiveness Report, 2014-2015 (Source of the data: World Economic Forum; IMF World Economic Outlook Database April 2014.)

As it is visible on the graph, and also reported by Schwab there is a strong positive relationship between the Global Competitiveness Index and GDP growth. It is worth noting that is not intended to measure contemporaneous associations: the GDP per capita head of a given year is regressed on the later edition of the index. Consequently, the effect of GDP on GCI is more emphasized. The results reported by Kordalska and Olczyk (2016) are similar in terms of variable choice, as the authors o used GDP annual growth rate and GCI. In terms of the method and the result their work is different, they used Granger causality and found that GDP growth Granger causes GCI, but the GCI's predicting force on GDP is rather weak and not robust to heterogeneity checks on income of the countries. There is however a caveat that on comparing levels of GCI and GDP growth, which can be remedied by a slightly different set of variables and the application of the conditional beta convergence is expected to improve the results. This is discussed in the next chapter.

3.4 Comparing changes of GCI and GDP growth and applying beta convergence

The beta convergence or namely the catching up effect of poor countries (Sala -i Martin – Barro, 1991; Barro, 2012) can provide a relevant dimension to the modelling of the relationship of GCI and GDP per capita. With the very ambitious assumption that all counties have reached their respective steady states, it would be that case that more competitive countries would grow much slower, just as poor countries would grow faster, due to the process of catching up to rich countries. This is however not what can be observed in reality.

Furthermore, in lieu of comparing GDP per capita growth and the global competitiveness index, it is more expedient to approximate the true relationship by comparing GDP per capita growth and the *changes* of the index value. The equation below is the statistical formulation of the relationship of the index and GDP growth, while accounting for the phenomenon of beta convergence. (Equation 1) This equation posits that the growth of GDP per capita is a positive function of the changes Global Competitiveness Index, while being negatively proportionate to the initial level of GDP per capita. Schwab and his co-authors (2015) used the following variables for this general equation: long differences of GDP per capita for the same, fairly long period between 1990 and 2012 regressed on the initial level of GDP per capita for the year 1990 (y_{yt}) , and the log scores of the 2014-2015 GCI. They found that the log coefficient of GCI is 0.07 and the coefficient on the initial level of GDP per capita is –0.01, both statistically significant, outcome variable being the growth on GDP per capita.

$$\log\ \gamma_{yi} = \alpha_0 + \alpha_1 \times \ln(\mathrm{GCI}_i) - \beta \times \ln(y_{yt}) + \varepsilon_i$$

Equation 1 Log GCI and log growth GDP (Barro and Sala-i-Martin, 2004 Schwab, 2015)

As demonstrated by the plot (Figure 2) the association is evident between the long differences of GDP between 1990 and 2012 and the log values of the 2014/2015 index. This serves as an unambiguous link between the gross domestic product per capita and the global competitiveness index, all while allowing for the effect of beta convergence to take place

However, the design of this equation is rather to enable the GDP to be used to estimate GCI, and less the other way around. (Since the period for the GDP growth, as the outcome variable precedes the year of the included Global Competitiveness Index in time.) Yet, it gives a very useful insight on the relationship of the GCI and GDP and provides an important reference point for the empirical analysis of this paper.

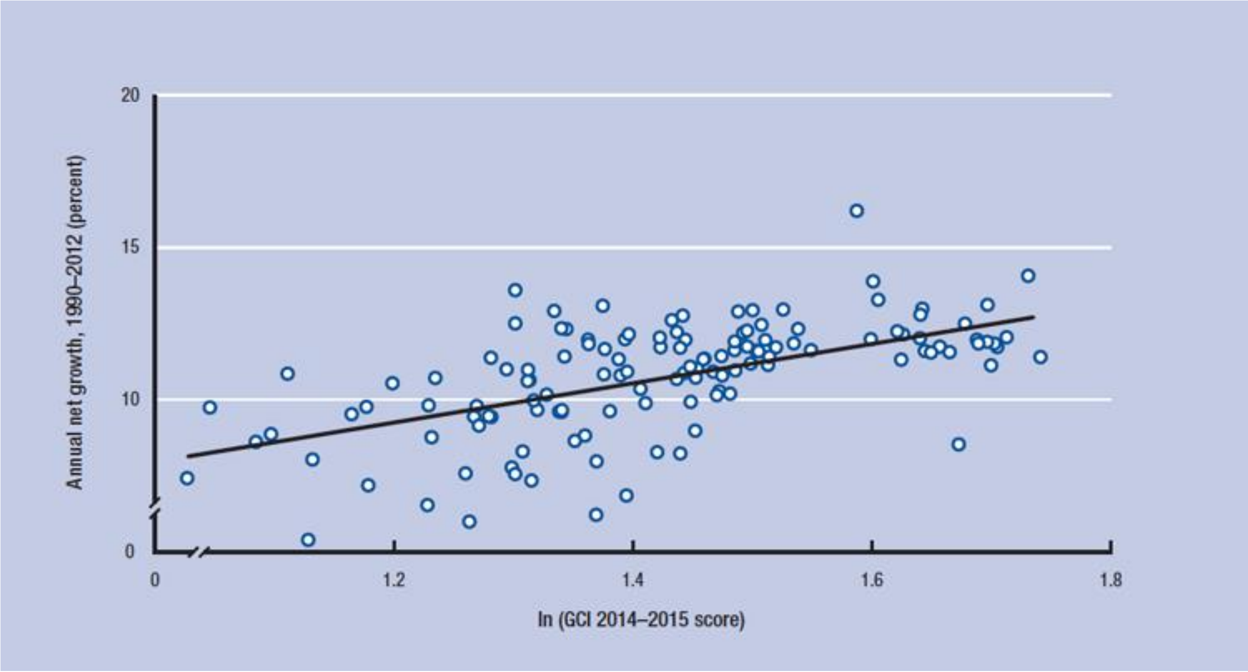

Figure 2 Log GCI and GDP per capita changes for 132 countries (net of convergence effect)
Source: World Economic Forum and World Bank, World Development Indicators

Furthermore, this model uncovers only the general differences between GDP and the Global Competitiveness Index. Looking into the components of the indicator can help find out more about the separate relationship of each country.

3.5 Components of the GCI Stages of growth model by Porter and the

The ranking which is published each year is based on an indicator ranging between the theoretical values of 1 and 7. The index is composed out of many (approximately 110) sub indicators which is aggregated up to twelve pillars. The conditions captured by these twelve pillars are the major essential elements of competitiveness.

All indicators of the GCI area categorized along Porter` model of stages of economic growth (Porter, 2011), which efficiency or investment and innovation driven stages. (Table 1)

Factor driven growth (Pillars 1-4)	Efficiency driven growth (Pillars 5-10)	Innovation driven growth Pillars (11-12)
1) state of institutions; (2) state of infrastructure; (3) macroeconomic stability; (4) health and primary education;	5) higher education and training; (6) market efficiency of goods; (7) labor market efficiency; (8) sophistication of the financial market; (9) technological upgrade; (10) market size	(11) business sophistication; (12) innovations

Table 1 Pillars of the index, according to stages of growth (Schwab, 2009)

These pillars are further broken down into indices, with a multiple level of aggregation. Within a pillar, and all the subsequent levels the weights are fixed. However, on the higher levels weights change based on which stage of development is the given country is.

As noted by Porter, the challenges, which a nation faces, are shifting at each stage (Snowdon and Stonehouse, 2006). With transitioning to a higher stage of development and with the accompanying increase of the GDP per capita, ranging from the need of building appropriate infrastructure to producing top notch innovation. For this reason, the index accounts for the differences between the countries at distinct stages of development. For poor countries the factor driven condition of growth are put 60% percent, while for developed country it is naturally a much smaller fraction of the overall value (Howell, 2013). When it comes to the construction of the methodology of the pillar, some argue (Carvalho, 2012), that the pillars suffer from heavy autocorrelation, large fraction of the competitiveness can be explained by only three out of the pillars. In the analysis part, the index will be broken down into some of the pillars, as to see whether they have a similar explanatory power when it comes to GDP. Now, however, the overall GCI and GDP beta convergence relationship will be covered in the first part.

Chapter 4 Analysis[1] and results

The analysis consists of two main parts. The first part can be broken down into three further class first, use a fairly broad sample to capture the contemporaneous effects, using data for the period 2010 and 2015. Then, to add depth to the analysis panel data is used for the period 2005-2015, although with a restricted set of countries, compared to the initial sample. The models presented are first differences and fixed effects. Next, as an attempt to capture the long term relationship between GDP and the global competitiveness index, long differences will be used. At the last stage of the panel data analysis, heterogeneity checks will be included to see whether the results are robust across different group of countries (rich – poor, open economy- closed economy). In the second part the most important models are recreated, however with different explanatory and outcome and variables (components of the index and gross value added per capita as an alternative measure for productivity)

[1] All subsequent tables and equations in this analysis – if source not otherwise specified – are my own work, using the following data sources : World Economic Forum and World Bank databank.

4.1 Data

The GDP data used for the analysis was retrieved from the World Bank DataBank website. For the analysis, I used constant GDP per capita on international dollars, which enables a better comparison by showing purchasing power parity. (In all regressions for GDP per head measures are used, even if not explicitly labelled as per capita.) The Global Competitiveness Index is available from the World Economic forum site for the period 2006-2016, resulting in a ten year available time period. The indicators are published for every year pair such as 2008-2009, 2009-2010 etc. In the following analysis the earlier of the year is taken as a label from the year pairs and used to match the appropriate years of the GDP data. (So for instance the indicator for the year 2006-2007 gets labelled as simply 2006, for the sake of easier handling.) The index is based on a value ranging between 1 and 7. Here a higher value evidently means a higher country ranking. For the preliminary analysis the value was chosen over the ranking because it contains more information. At a later stage of the analysis sub-indices are also included as to see whether they are more powerful at predicting GDP with respect to the main index.

The broadest sample consists of 121 countries (listed in Appendix, Exhibit 1). However, at certain regression specifications in the analysis, the number of observations are much less than that, due to methodological considerations, such as working with a fully balanced panel, or compare multiple models on an identical sample. Nevertheless, the set of 121 countries is already a restricted set compared to all countries of the world, so this needs to be taken into account when drawing the final conclusions.

The values can range between 1 and 7, the actual values, however, tend to fall between 2 and 6, for most years. Below (Figure 3) is a density plot for the year 2012, for 121 countries.

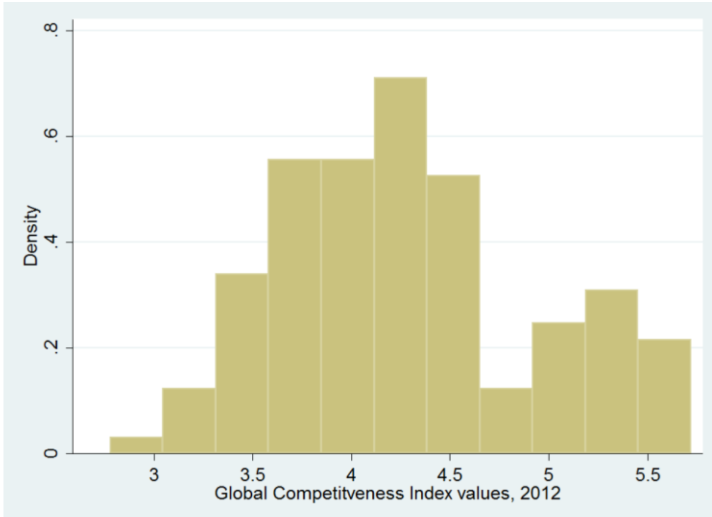

Figure 3 Histogram of the values of the Global Competitiveness Index values, 2012
Source: own work, data source: Word Economic Forum

By visualizing q-q and kernel density plots, it is obvious that neither GDP per capita not GCI follow a normal distribution. To remedy this, natural logs were taken. Where applicable in the model, first differences were taken, still the log differences of both variables show the signs of non-stationarity of the data.

4.2 Base model

The basic assumption is that a country's GDP growth is the function of their values of the changes Global Competitiveness Index. This is concisely captured by Equation 2.

$$\mathbf{GDP = f(GCI)}$$

Equation 2 Base model

To map the full relationship, beta convergence has to be taken into account as well. Beta convergence states that richer countries grow slower (Barro, R. J., & Sala-i-Martin, 1992), which, applied to the above model, signifies that where initial levels of GDP per capita are higher, log GDP change should be smaller. The main proposition is that the Global Competitiveness Index enables finding out more about the future productivity, proxied by GDP per capita, allowing for beta convergence. This is captured by the following model (Equation 3). In all subsequent equations, if not specified otherwise, the Δ symbol means yearly changes.

$$\Delta \text{GDP} = \Delta \text{GCI} + \Delta \text{GDPpcap}(\text{previous\_periods}) + \text{GDPpcap}(\text{level})$$

Equation 3 Beta convergence and GCI changes

Equation 3 captures how the changes of the GDP per capital values with the current levels of GDP per capita and the previous periods changes, while taking in to account the changes in of its competitiveness, measured by the log values of the Global Competitiveness Index. These variables are included to capture the growth of both GDP per capita and the Global Competitiveness index and yearly log values of GDP per capita are included to capture the different speed of growth as a function of the initial wealth of the country.

However, there are some caveats when it comes to exploring competitiveness of a country with the Global Competitiveness Index (GCI). By definition, the GCI was designed to capture long term economic competitiveness of a country. (Schwab et al., 2016) However, the availability of the data (Global Competitiveness Index are accessible only for the period 2005-2016), the analysis only allows the exploration of rather short term effects.

4.3 Cross section OLS

By plotting log - log values of the index and the GDP per capita data, between on the sample containing 121 countries (see in Appendix, Exhibit 1), the resulting graph is fairly similar to the one showing relationship between the log GDP capita for 2013 and the Global Competitiveness Index for 2014-2015. The only slight differences that is here a contemporaneous association is shown, while in the model by described by the report (Schwab, 2015) shows the lagged association between 2013 GDP per capita in logs and the *subsequent* year's index. Its objective is to prove the explaining power of the GDP on the index and less vice versa. Nonetheless the plot for the same year already shows the contemporaneous association between the two indicators, proving the evidence on this particular sample and calls for further investigation of the effect of GCI on GDP.

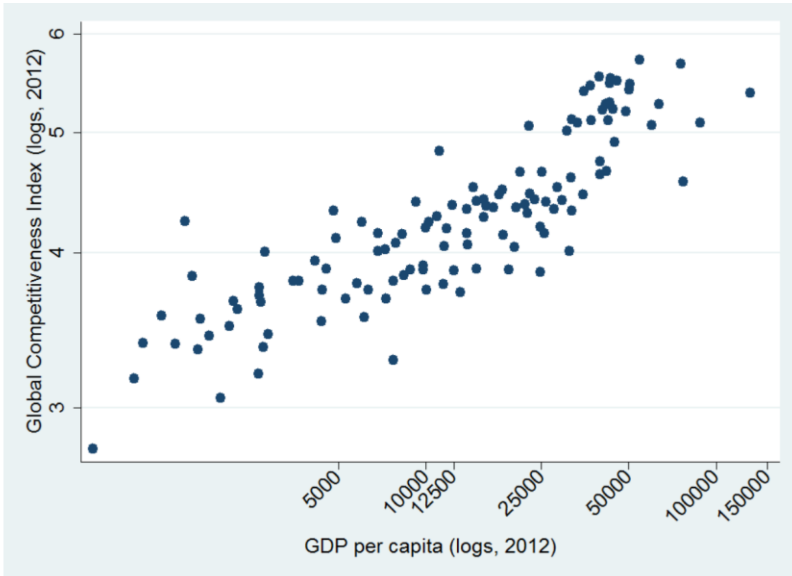

Figure 4 Log - log plot of the index and GDP per capita, 2012
Own work. Data source: World Bank, WEF

The first two models (described by Equation 4 and 5) aims to find contemporaneous associations, while Equation 6 formally shows the relationship demonstrated by the plot (Figure 4). The third model uses log one year changes instead of contemporaneous associations, while including the levels of GDP per capita for 2011, to account for beta convergence, the same period change for the index and the previous period change of the outcome variable, log change of GDP per capita between 2011 and 2012. (The Δ symbols mark the yearly changes.)

$$(1)\ GDPpcap_{2012} = \alpha + \delta GCI_{2012} + \varepsilon$$

Equation 4 Level-level regression, 2012

$$(2)\ logGDPpcap_{2012} = \alpha + \beta logGCI_{2012} + \varepsilon$$

Equation 5 Log -log regression, 2012

$$(3)\ \Delta \ln GDPpcap_{2012/2011} = \alpha + \xi_1\, GDPpcap_{2011} + \xi_2\, \Delta \ln GDPpcap_{2011/2010} + \xi_3 \Delta \ln GCI_{2012/2011} + \varepsilon$$

Equation 6 One year changes, 2011-2012

Dependent variable:	(1) GDP percap 2012, levels	(2) GDP percap 2012, logs	(3) Change of log GDP per capita, 2011 - 2012
GCI,2012	25,027.34***		
	(2,341.914)		
GCI logs, 2012		6.53***	
		(0.309)	
Log GDP per capita, 2011			-0.01***
			(0.002)
Δ LogGDP per capita, 2010 - 2011			0.43***
			(0.094)
Δ LogGCI 2011 - 2012			0.19*
			(0.095)
Constant	-86,219.79***	-0.02	0.08***
	(9,262.361)	(0.463)	(0.022)
Observations	121	121	121
R-squared	0.620	0.740	0.402

Robust standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 2 GCI GDP per capita, cross section, 2012

Note: The table contains cross section OLS for 2012, and changes from the previous year. Own calculations. Data source: World Bank, WEF

When interpreting the table above, the following relationship is apparent: a one unit higher value of GCI in 2012 is correlated with 25027.34 more GDP per capita, measured in constant international US dollars. (Specification 1) Similarly, index values being one percent higher is associated with approximately 6,5% higher GDP per capita, on average**.** (specification 2) This number is fairly high, but due to the specificities of the sample, is may not be true reflection of the relationship.

Table 2 aims to explore the very short term relationship between GDP and GCI. Previous year change of GDP per capita has been added, in the attempt to take care of any potential autocorrelation. 1 percent higher level of GDP is associated with approximately 0.01 percent lower change of GDP per capita in the next year, unlike in the model described in Schwab (2015), the initial year is fairly close to the examined period. Consequently, this doesn't reveal much about the beta convergence on the long term. The autocorrelation between GDP and its past values is strong: one percent higher change in the previous year is correlated with 0.43 % change between 2011 and 2012, which remains almost the same when adding the contemporaneous log changes of GCI. However, the effect of the change of GCI on the contemporaneous GDP growth is not significant. This is however, valid only for the change between 2011 and 2012, and doesn't necessarily portrays the long- term relationship

4.4 Panel data

To be able to separate the individual effects (Hausman, 1981) and to be able to remedy the omitted variable bias to a higher extent, the use of panel data is the next step. Thanks to the availability of data, both in their time and cross-sectional dimensions - the index being published for the last ten years for several countries – the power of the panel data can bring the analysis to closer to causality, as well. When it comes to exact sample size, it varies according to the availability of the data for most models and specifications, constantly adjusting the number of observations to have a balanced panel across all specifications. All panel models are similar to the one described in the literature review Schwab (2015), in terms of using differenced values of the Global Competitiveness Index, and the growth of GDP per capita. All models incorporate levels of GDP per capita (instead of differences) as well, to account for the presence of beta convergence. However, there is an important difference in the approach. The purpose of the model described in the report is to justify that GCI is a valid measure of productivity proxied by GCI. The periods covered for GDP are earlier than the ones for the index (as represented by Figure 2 on page 9).

Yet, in the subsequent analysis of this paper, the aim is to disentangle the potential effect of GCI on future GDP, for this reason same period differences and lags of the index are incorporated.

4.4.1 Description of the panel data

The yearly panel data analysis encompasses the period 2006 and 2015, balanced out to 108 countries, which are present both in the GCI and the GDP per capita data. (see the list of countries in the Appendix, Exhibit1). The addition of further control variables – depending on the availability of other indicators - , can further shrink the dataset, as the comparison of the different results requires a fully balanced panel.

4.4.2 First differences

The assumption is that the change of the Global Competitiveness Index affects or at least exhibits a strong association with the GDP growth on the short term, after having discounted for the effect of beta convergence. To empirically test this, first differencing model seems an optimal choice, which controls for all the confounders stable over the long term. Difference-in-differences also mitigates the autocorrelation of the variables, which helps steer the analysis towards causality Here also, the log transforming and differencing of the variable serves the purpose of remedying the problems of non-stationarity, as well. Due to the small number of available years, it doesn't make sense to include a high number of lags, even though the coefficient on those may be higher. First differences model serves as a basis for comparison for other panel data models.

Adding lags to both the log values GDP per capita and to the log Global Competitiveness Index helps to show the delayed effects. Due to the narrow time frame, it's not expedient to include a high number of lags, because that results in a diminishing number of observation, for each additional year lost. Similarly to the OLS specification, the same number of lags for the log GDP is included to account for the effect of autocorrelation with its past values. Adding log GDP per capita (thus not differenced values) serves to locate the phenomenon of beta convergence in the sample data. By definition, the assumption is that the coefficient should be negative, given that GDP change is conversely related with the current level. Equation 7 describes the model. For easier readability in Equation 7, lnGDP per capita is marked as "prod". The Δ symbol in Equation 7 marks the yearly changes.

$$\Delta\,(\text{prod})_t =$$

$$\alpha + \xi_1\,\Delta\,(\text{prod})_{t-1} + \xi_2\,\Delta\,(\text{prod})_{t-2} + \xi_3\,\Delta\,(\text{prod})_{t-3} + \xi_4\,\Delta\,(\text{prod})_{t-4} +$$

$$+ \beta_0\,\Delta\,(\ln GCI)_t + \beta_1\,\Delta\,(\ln GCI)_{t-1} + \beta_2\,\Delta\,(\ln GCI)_{t-2} + \beta_3\,\Delta(\ln GCI)_{t-3} + \beta_4 \Delta \ln\,(GCI_{t-4})$$

$$+ \lambda\,(\text{prod})_t + \varepsilon$$

Equation 7 First differences of GDP per capita and contemporaneous GCI changes

As it is reported by Table 3 on the following page, the Global Competitiveness Index seem to have the similar effects over the models with one, two and three lags included whereas the effect is smaller in the case of the fourth lag. The sudden drop of the coefficients might be due to the very nature of first difference regressions. By one additional lags, some observations are lost. In this case, the GCI - GDP relationship was the strongest for those country observations, which are eliminated due to first differencing. The cumulative associations on the fourth lag are almost zero since the lag effects with different signs balance out one another. (See table with cumulative effects broken down into years in Appendix, Exhibit 4) By interpreting the FD(2) model, the following relationship can be observed: when the value of the index changes one percent in one period (and no further increases afterwards), than it is expected that the GDP per capita will be 0.3 % higher, by the end of second period which follows.

Outcome variable: Δ log GDP per capita	(0) No lag	(1) FD(1)	(2) FD(2)	(3) FD(3)	(4) FD(4)
Log GDP percap = L,		0.41***			
		(0.055)			
Log GDP percap= L2,			0.35***		
			(0.080)	0.48***	
Log GDP percap = L3,				(0.058)	
					0.57***
Log GDP percap = L4,					(0.069)
Log index = D,	0.19***				
	(0.074)				
Log index = L,		**0.31****			
		(0.094)			
Log index = L2,			**0.31*****		
			(0.123)		
Log index Index = L3,				**0.31*****	
				(0.100)	
Log index = L4,					0.20
					(0.136)
Log GDP percap	-0.01***	-0.00***	-0.00**	-0.00	-0.00
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Constant		0.04***	0.05***	0.02	0.01
		(0.011)	(0.015)	(0.012)	(0.011)
Observations	972	864	756	648	540
Adjusted R-squared	0.262	0.401	0.392	0.296	0.344

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3 Panel data first differences, cumulative effects up to four lags
Dependent variable is the log differences of GDP. Year fixed effects are included and standard errors are country clustered.

GDP per capita, in the same model, can be interpreted in the following way: 1% percent growth of GDP per capita is associated with 0.35% increase by the end of the second subsequent period, given it doesn't change after the increase. Comparing this model with the one where only the value of log GDP is included, the coefficients do display some change. For instance, the cumulative effect for the same FD(2) model is 0.38%, (See in Appendix, Exhibit 5), which is slightly higher than 0.35%, in the model including GCI. This can mean that the Global Competitiveness Index does amend the only GDP model. (This is being corroborated by the comparison of the adjusted R squared values, it is clear the GCI-included model fits the data better compared to the only GDP one. When comparing the two models with the F test, all p values are smaller than the 5% threshold so it can be concluded that added variables for GCI ameliorate the only-GDP model). The Global Competitiveness Index, therefore, plays a role in remedying omitted variable bias of the regression that contains only the past changes of GDP. However, the initial values of log GDP do not seem to have an economically significant effect (although the coefficients are negative in some specifications, essentially they are indistinguishable from zero.)

The results by enlarge support the initial assumption of short term and contemporaneous association of the changes of Global Competitiveness Index with the GDP per capita growth. Although, by the insignificant coefficients of log GDP per capita, there is no overwhelming evidence for beta convergence. This is probably because of the relatively narrow time frame of the data, and the phenomenon probably needs a longer time to take place. (as described by Barro and Sala-i-Martin,1992)

4.4.3 Fixed effects

To check the results of the first differences, I included fix effects, for the same panel. The objective is very similar then in the case of the FD model - to find out about the association of the GDP per capita and GDP for the time period covered by the data. Fixed effect measures changes, just as first differencing does but unlike the latter, it cannot locate the exact years where the change takes place. FE meanwhile it takes care of the cross country differences that are stable over time (e.g. culture).

In Table 4 fixed effects show a stronger relationship between the two variables, although the goodness of fit to the sample data is very similar than in the case of first difference estimators. The model serves to check against the results of the first differences model, doesn't offer an alternative to is, given the fact that it is not capable of showing the effects of the beta convergence across time.

$$\mathrm{GDPpcap}_{\mathrm{country,year}} = \alpha_{\mathrm{country}} + \beta \mathrm{GCI}_{\mathrm{country,year}} + \varepsilon$$

Equation 8 Fixed effects model

$$\mathrm{GDPpcap}_{\mathrm{country,year}} = \alpha_{\mathrm{country}} + \beta \mathrm{GCI}_{\mathrm{country,year}} + \xi \mathrm{year}_t + \varepsilon$$

Equation 9 Fixed effect model, with year dummies

	(1) Fixed effect	(2) Fixed effect, with year dummies
Log values of Global Comp Index	1.35*** (0.186)	0.86*** (0.168)
Constant	7.51*** (0.269)	8.14*** (0.244)
Observations	1,080	1,080
Number of countries	108	108
Adjusted R-squared	0.227	0.462

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4 Fixed effects, period 2006-2015

Note: This table shows fixed effect regression on log GDP per capita as dependent and log Global Comp Index as independent variable. In the second columns year dummies are included, not displayed
Source: Own calculation, using World Bank, WEF data

The model shows the following association: when comparing two countries that have different levels of the global competitiveness index, in the country, where GCI was one percent larger than its long-term mean, on average GDP per capita is 1.35 percent higher than its long-term (10 years) mean When adding year dummies, this coefficient on log GCI shows a still significant but weaker association.

Fixed effects validate the assumption of short- term relationship between the changes of the Global Competitiveness Index and the GDP growth. In comparison to the first differences regression the correlation is more apparent. This might be due to the different biases of each model. The result is not sufficient for causal interpretation. One of the reasons is that the regression may be affected by time-variant confounders. Only correlation is apparent so far for the ten years covered by the data, corroborated by both first differences and fixed effects models.

4.4.4 Long differences

In essence, the Global Competitiveness Index is designed to predict and show long term associations with output (Schwab, Sala-i-Martín, 2016). It makes sense to see those effects by a regression model. The optimal choice for that is a long differences model, given the limitations of the data. Long differences model is also capable of setting off the potential effect of business cycles of GCI on GDP, given the time period in the data covers at least one full cycle.[2] Below is the model, including the initial level of GDP per capita, to account for beta convergence (Equation 10). Here the Δ symbol marks the change between the years 2006 and 2015.

$$\Delta \mathrm{lnGDPpcap}_{2015/2006} = \alpha + \beta lnGDPpcap_{2006} + \delta \Delta lnGCI_{2015/2006} + \varepsilon$$

Equation 10 Long differences

The results of the regression described by Equation 10, can be found in the following page, in Table 5. The effect of beta convergence is clearly manifests in the long term association – at least compared to the short-term models. 1% higher GDP per capita in 2006 is associated with a -0.07% GDP per capita change from 2006 to 2015. The long term effect association with the same period change of Global Competitiveness Index on the subsequent ten period GDP growth is 0.7 percent (significant at 5%.) The reason for the moderately high values can be that common trends

[2] National Bureau of Economic Research reports business cycles duration in the US as being six years on average. http://www.nber.org/cycles.html . Nevertheless, this serves only as a guideline, shorter or longer cycles may apply throughout different periods and countries.

assumption is less valid on the long term, compared to short term. This assumption posits that GDP per capita of in country changes to the same extent on average, if the country experiences the same change in the value of the global competitiveness index. On the other hand, the number of observations are reduced in the long differences model, compared to first differences. Due to the small number of observations, some effects of the GCI, overarching the 2005-2016 period, may not be incorporated in this model. Based on this model, there is a moderate association between the changes of GCI and GDP per capita growth on the longer term.

	(1) Long difference of the index, 2006-2015
l	
Log GDP percapita, 2006	-0.07***
	(0.017)
Log Global Comp.Index, 2006	0.72** (0.336)
Constant	0.78***
	(0.164)
Observations	108
R-squared	0.295
Adjusted R-squared	0.282

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5 Long term associations of GDP per capita and GCI, 2006-2015

This table contains long difference changes of GDP per capita (years 2006 and 2015) as dependent variable and log GDP per capita and log values of GCI, both for the year 2006 as right hand side variables
.

In comparison with the model described by the report (Schwab, 2015), where the outcome variable is the GDP per capita growth between the years 1990 and 2012 and the 2014 log GCI score is used as an explanatory variable, the coefficient on GCI is much higher (0.07 versus 0.7) although less significant. A similar result is valid for beta convergence, while the coefficient for the above long difference regression is -0.07, in the model described by the report this coefficient is -0.01, meaning a weaker evidence for the slower growth of relatively richer countries. The discrepancies of these results may emanate simply from the research design: in the attempt to validate GCI against GDP, earlier periods for the latter were included (1990-2012 change versus the 2014 index).In the long differences model described above simultaneous periods for GCI and GDP were used (2006 and 2015 period change, for both). As a result, due to the different purposes (validate GCI against GCI versus to find out about the short term effect of GCI on GDP) might eliminate the grounds for comparison.

4.5 Choosing the adequate model and heterogeneity checks

From the above listed models (cross section OLS, FD, FE, LD) there should be one which is closest to show the true relationship. Although the adjusted R squared, meaning the models fit to the sample, given the number of regressors , s the highest in the case of fixed effects, it doesn't necessarily qualify it as the most adequate model for the purposes of this analysis. Inasmuch as the number of the time periods is fairly low, the benefit of using fixed effects cannot be captured to its full potential since its better used in discovering overarching association for the whole period covered. On the other hand, first differences, in this case, may mitigate better the problems arising from stationarity. Also, with first differences, the lagged effects can be discovered, meaning if the index changes in one period how it will affect the GDP in later periods.

As the goodness of fit is the best for the models FD(1) and FD(2) these are the ones that helps discover the relationship using the sample data. It needs to be considered, however, that the 108 sample country is not a truthful representation of all countries of the world, this does not necessary entail that these models are the closest ones to the real association. Still, using a small number of lags is more expedient, as they are not yet affected by the overarching business cycles, which can drive the aggregate trends behind both the changes of GDP per capita and the indicators making up the values of the Global Competitiveness Index. As a consequence, the FD(2) model is chosen as the most appropriate in showcasing the relationship amongst the short term panel models specified up to this point.

In order to see, if the results are consistent to across countries to measure heterogeneity, robustness checks are included. By adding further control variables, the heterogeneity effect can be separated from the general effect of the Global Competitiveness Index and the analysis has a higher explanatory power. However, due to the availability of trade data, the sample had to be further restricted to 70 countries, which means seven hundred observation altogether in the balanced panel. When considering the reduced number of lags to the first differencing with two lags, the observation count in the sample used plummets to 450. This makes it difficult to draw inferences for the full sample of 121 countries, or make further general conclusions. Results are in Table 6:

	(1) FD(2)	(2) Poor country	(3) Rich country
Log GDP per capita	-0.01*** (0.001)	-0.00 (0.003)	-0.02*** (0.005)
Log values of GDP per capita=L2,	0.29*** (.087)	0.32*** (0.134)	0.19* (0.095)
Log values of Global Comp Index = L2,|	0.57*** (0.132)	0.59*** (0.178)	0.62*** (0.215)
Constant	0.07*** (0.015)	0.04 (0.030)	0.18*** (0.055)
Observations	490	245	245
R-squared	0.494	0.380	0.630
Adjusted R-squared	0.481	0.339	0.606

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6 Robustness checks on FD (2) Poor country - Rich country
The table displays first differences regression with 2lags, log differences of GDP per capita being the outcome variable. The regressors are the initial GDP per capita, log GDP per capita and log GCI, cumulative up to two lags. Standard error clustered by countries and years effects are absorbed.

I tested the FD(2) model, whether the association is the same for countries of different income levels, this latter approximated by GDP per capita. The restricted sample were divided into rich and poor country based on the GDP per capita. If a country`s GDP per capita is higher than the sample mean then it was labeled as rich and if its lower then it is categorized as a poor country, for the sake of the analysis. (Table 6)Beta convergence has lost its small significance for the poor countries, but became more slightly more significant for the rich category. When interpreting the coefficients on GCI, the following conclusion can be discovered: in case of poor countries if the Global Competitiveness Index showcases a one percent change in a period (with no further change), than it is expected that the GDP per capita will change by 0.6% altogether by the end of the second period. Although, surprisingly, beta convergence only seems to be present for the rich counties in the sample, the effects of GCI is consistent for throughout different income levels.

Positing that more open economies benefit more of being more competitive thus, they will have more advantages of having a high place in the Global Competitiveness Index ranking. As a result, I measured heterogeneity for open and closed countries, whether the correlation of changes Global Competitiveness Index and GDP growth is robust to the distinction, in terms of the so far discussed FD(2) model. To investigate that "Trade as a percentage of GDP on current US dollars"[3] data were used, as a proxy for measuring openness. Using cumulative effects for the same FD(2) model, the data was separated into close and open, according to the value of the indicator being higher or lower for the given country than the sample mean. Results can be found in Table 7 on the next page.

[3] Data from World Bank Databank http://databank.worldbank.org/data/home.aspx

	FD(2)	Closed economy	Open economy
Log GDP percapita	-0.01***	-0.00	-0.01***
	(0.001)	(0.003)	(0.002)
Log values of GDP per capita=L2, cumulative	0.29***	0.27***	0.30***
	(.087)	(0.131)	(0.123)
Log values of Global Comp Index = L2,| cumulative	0.57***	0.66***	0.44
	(0.132)	(0.155)	(0.246)
Constant	0.07***	0.05	0.09***
	(0.015)	(0.028)	(0.023)
Observations	490	245	245
R-squared	0.494	0.436	0.610
Adjusted R-squared	0.481	0.399	0.585

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7 Robustness checks, Closed – open economy

The table displays first differences regression with 2lags, log differences of GDP per cap being the outcome variable. The regressors are the initial GDP per capita, log GDP per capita and log GCI, cumulative up to two lags. Standard error country clustered and years effects are absorbed.

The results can be interpreted as follows: for the closed economy in a country where global competitiveness index changes by one percent, it is expected that the GDP will be 0.66 percent higher by the end of the following two periods. Surprisingly, the coefficient on the global competitiveness index is not robust to the open economy specification. The reasons for that are not entirely straightforward. It might be due to the specificities of the indicator or the small number of observations in the sample.

However, in general the results remain robust to the specifications, in this restricted sample. Nevertheless, the general conclusions from these results should be drawn very carefully, since the countries in the sample represent less than 40% of all countries of the world.[4]

4.6 Testing further dependent and explanatory variables

4.6.1 Components of the index

The results so far show a relatively strong specification over the short term between the index, and the GDP per capita. The question is whether is there any specific component of the index that drives this result. To find this out, I tested three components of the index, three pillars pertaining to a different growth stage and respectively a different set of drivers of competitiveness: Factor driven stage - "Basic requirements", Investment driven stage - "Efficiency enhancers", Innovation driven stage -" Innovation and Sophistication factors" (Schwab et al., 2016). Each pillar manifests in a value ranging between 1 and 7, similarly to the main index. For nations in different stages of growth the weight for each group differs. For instance, for countries in the factor driven stage, the aggregate indicator of the "basic requirement" weighs the most, while for countries in the second stage, the efficiency driven growth, efficiency enhancers are the most emphasized when calculating the index. However, when it comes to lower level of aggregations (e.g.; pillars or components of pillars), there is no weight involved, so within the pillars the same structure of weights apply to all included country.

The purpose of doing these regressions is to locate if a particular pillar, from either of the three growth stage, is more important than the others compared to the full index. Given these

[4] The number of countries of the world is not straightforward to declare accurately according to the WordAtlas website http://www.worldatlas.com/nations.htm. For the purposes of this paper, by all countries only that countries of those belonging to the United Nations are considered, although actually many more than that including other independent countries and approximately sixty disputed territories.

sophisticated weighing methods discussed above, it is not necessarily expected that any association will be apparent. The reason for that that our sample contains a different set of countries where the presence of countries from a specific growth stage group would be more pronounced. For each of the pillars, the main models were fitted, for each time frame (cross section OLS, first differences with two lags and long differences respectively for contemporaneous, short term and long term associations) These are as shown by Equation 11, by Equation 12, and by Equation 13. In these equations "pillar" marks the components of the index.

$$(1)\ \ln GDPpcap_{2012} = \alpha + \delta Pillar_{2012} + \varepsilon$$

Equation 11 Log-log regression 2012, Pillar (index component)

$$(2)\ \Delta \ln GDPpcap_{t} = \alpha + \xi_1 \Delta \ln GDPpcap_{t-1} + \xi_2 \Delta \ln GDPpcap_{t-2} + \beta_0 \Delta \ln Pillar_{t} + \beta_1 \Delta \ln Pillar_{t-1} + \beta_2 \Delta \ln Pillar_{t-2} + \ln GDPpcap_{t} + \varepsilon$$

Equation 12 First differences model (FD), Pillar (index component)

$$(3)\ \Delta \ln GDPpcap_{2015/2006} = \alpha + \beta \ln GDPpcap_{2006} + \delta \Delta \ln Pillar_{2015/2006} + \varepsilon$$

Equation 13 Long differences, Pillar (index component)

In order to be able to see that how an individual pillar performs compared to the index, the same set of the above mentioned regressions were done on the given pillar and the index, as well. However, in the case of the Institutions (1st pillar) and Innovation (2nd pillar) components, due to a large number of missing data, the balanced panel contains only a very few number of observations. (See the regressions for those in the Appendix)

Fortunately, for the component of the Goods market efficiency pillar more data was available, so I could build a panel of 106 observations per year. The pillar largely consists of indices such as domestic and foreign competition and quality of demand conditions, which can be broken down into further components. Below the same FD(2) model was used in the data as previously with the competitiveness index as an outcome variable. By and large the component does not show statistical significance in this model. This can be due to the composition of the sample. The "Goods market efficiency" pillar belongs to that group of countries, which are given extra weight for the efficiency driven phase. Consequently, the ratio of these countries in the given sample can heavily influence the results. As to compare the same regression on the log Global Competitiveness Index on a balanced panel, the sample needed to be restricted to 106 observations per year. Below are the three most important models, OLS for 2012, first differences with two lags and long differences. Here only the equation for the components is plotted, the same is valid for the values of the Global Competitiveness Index.

The first model is the cross section a log-log OLS for the year 2012. (See Equation 11 and Table 8). For this particular year, the coefficient on Goods market efficiency is statistically not distinguishable from the one on log GCI. Still based on the reported R squared, the fit of the former is much worse in terms of fitting to the sample.

Dependent variable	(1) Log GDP per capita	(2) Log GDP per capita
Log values of Goods market efficiency GCI component	6.48*** (0.941)	
Log Global Comp Index		6.61*** (0.315)
Constant	-0.03 (1.429)	-0.12 (0.471)
Observations	106	106
R-squared	0.471	0.768

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 8 Goods market efficiency, cross section OLS 2012

The next model is first differences with lags, showing only the cumulative association. This model, as in case of the first part of the analysis, also includes log GDP, in order to see if there's any effect on beta convergence and also the same number of lags for GDP per capita, in order to remedy the effect of autocorrelation. Below are shown the equation and the regression for this model.

When interpreting the model (specification 1) , the following association is apparent: if the value of the Goods market efficiency increases by one percent (and no further change takes place), then the GDP per capita is expected to change by 0.2 percent (result significant at 5%). This is however much weaker association with the GDP in comparison to the result with the Global Competitiveness Index. (specification 2)

Dependent variable:	(1) Log changes GDP per capita	(2) Log changes GDP per capita
Log values of GDP per capita	-0.00**	-0.00**
	(0.002)	(0.002)
Log values of GDP per capita = L2,	0.37***	0.35***
	(0.078)	(0.081)
Log Goods market efficiency pillar = L2,	0.19**	
	(0.072)	
Log index =L2		0.30***
		(0.126)
Constant	0.04***	0.05***
	(0.016)	(0.015)
Observations	742	742
R-squared	0.395	0.402

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 9 First differences, Goods market efficiency pillar
Comparing the index and the Goods efficiency pillar, on the same set of 106 countries, showing cumulative associations up to two lags, years absorbed and standard errors country-clustered.

The third model is long differences, regressing the change 2006-2015 of the Goods market efficiency values on the same period change of GDP per capita, while including log values of GDP for 2006 to discount the beta convergence effects. (Model described in Equation13)

The results show markedly the presence of beta convergence on the long term, the coefficients on the log values of GDP per capita being negative. (Table10) Long term change in the Goods market efficiency pillar does not seem to be associated with a simultaneous change of the GDP per capita values. (see column 1 in Table 10) When looking at the same model, using the same sample, the long changes of the Global Competitiveness Index shows a significant relationship with the long term GDP per capita growth.

VARIABLES	(1)	(2)
	Dependent variable: Δ Log GDP per capita 2015/2006	
Log values of GDP per capita, 2006	-0.05**	-0.05**
	(0.020)	(0.019)
Log Goods market efficiency LD 2015/2006	0.37	
	(0.184)	
Log Global Comp Index LD 2015/2006		0.93**
		(0.379)
Constant	0.61***	0.62***
	(0.197)	(0.186)
Observations	106	106
R-squared	0.171	0.214

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 10 Long differences 2006-2015,,Goods market efficiency pillar

All in all, while the cross sectional OLS and first differences display a slight correlation, there is no overwhelming evidence for the relationship of one pillar of the index Goods market efficiency. However, the associations of Global Competitiveness Index and GDP per capita are quite conspicuous, using the same sample.

To summarize, when testing on an appropriately large sample, there are some components which may show a significant relationship with GDP per capita growth, this result is to be taken with a grain of salt. The result is largely dependent upon the composition of the countries in the given sample because they are given a different weight based on their main driver of competitiveness (basic requirements, efficiency drivers or innovation drivers). This in turn can distort the results, when looking at lower levels of aggregations (e.g. pillars, indices)

4.6.2. Gross value added per capita

Even though, the main focus of this paper is the GDP per capita, as the most adequate proxy for competitiveness as suggested by Porter (Porter, 2015), it is interesting to see the relationship of the Global Competitiveness Index with other indicators. As the Global Competitiveness Index claims to be a valid estimate of GDP, it is assumed to show a relationship with other measures of productivity such as gross value added. Gross value added (GVA) can be defined most expediently for the purposes of the analysis as GDP plus subsidies minus taxes on products.[5] It is conceptually very similar to GDP and in some instances can account for the distortion of the latter and vice versa. (ECB, 2003) For this reason, it is used as an alternative measure for productivity.

The three most essential panel models were used (OLS, first differences with two lags and long differences) to test the Global Competitiveness Index against other measures of productivity. (The equations are shown below.) To be able to check the indicator against GDP per capita and still have a balanced panel, the dataset was restricted to 91 observations per annum.

$$(1)\ \ln GVApcap_{2012} = \alpha + \delta GCI_{2012} + \varepsilon$$

Equation 14 Log-log regression 2012, Pillar (index component)

$$(2)\ \Delta \ln GVApcap_t = \alpha + \xi_1 \Delta \ln GVApcap_{t-1} + \xi_2 \Delta \ln GVApcap_{t-2}$$

$$+ \beta_0 \Delta \ln GCI_t + \beta_1 \Delta \ln GCI_{t-1} + \beta_2 \Delta \ln GCI_{t-2} + \ln GVApcap_t + \varepsilon$$

Equation 15 First differences model (FD), Pillar (index component)

$$(3)\ \Delta \ln GVApcap_{2015/2006} = \alpha + \beta \ln GVApcaP_{2006} + \delta \Delta \ln GCI_{2015/2006} + \varepsilon$$

Equation 16 Long differences, Pillar (index component)

[5] Definition by Eurostat, retrieved from http://ec.europa.eu/eurostat

Cross section, 2012

A quick visual check of the relationship doesn't project any significant relationship in terms of the association of the two indicators.

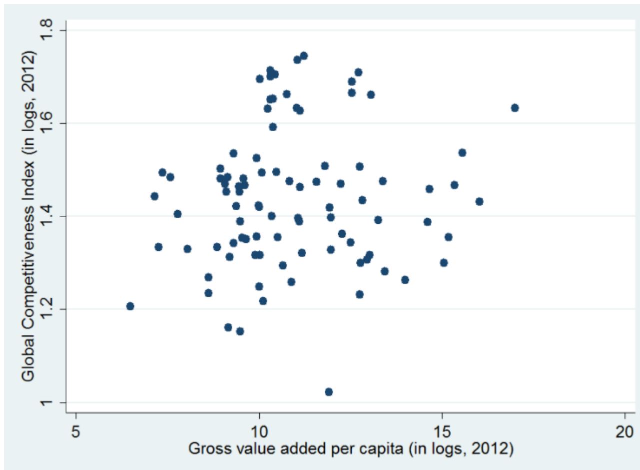

Figure 5 Log GCI and log GVA per cap, year 2012

This is upheld by the subsequent OLS regression results, for the year 2012. There is no significant relationship for the particular year between gross value added and GDP. This is most likely due to the fairly different distribution of GVA compared to GDP for the particular year.

	(1) Log GVA percapita	(2) Log GDP per capita
Log values of Glob. Comp Index	1.37	6.60***
	(1.267)	(0.329)
Constant	8.96***	-0.10
	(1.864)	(0.495)
Observations	91	91
R-squared	0.009	0.775

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 11 Cross section 2012, log GDP and log Gross value added, per capita

Nevertheless, it may still be worth to look at the two other models, to actually compare the changes of the index and GVA per capita.

First differences with two lags, cumulative effects FD(2)

The assumption is that the gross value per capita would exhibit similar association with the changes of the index, as the GDP does, when comparing log changes and accounting for beta convergence.

	(1) Δ Log GVA percapita	(2) Δ Log GDP per capita
Log gross value added per capita	0.00	
	(0.001)	
Log gross value added per capita = L2,	0.27**	
	(0.111)	
Log values of Glob. Comp Index = L2,	**0.34*** **	**0.36*** **
	(0.141)	**(0.129)**
Log GDP percap		-0.00**
		(0.002)
Log GDP percap= L2,		0.27***
		(0.086)
Constant	0.00	0.05***
	(0.009)	(0.017)
Observations	637	637
R-squared	0.284	0.379

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 12 First differences, with cumulative lags, up to 2 (GVA per capita)
Years are absorbed and standard errors country-clustered.

When interpreting the result the following association is apparent, if the index changes by one percent (not followed by any subsequent changes), then by the end of the second period GVA per capita changes by 0.34 percent. This result is very similar to that of the GDP per capita. Also in terms of correlating with its past values the coefficients of GDP and GVA are statistically identical

Long differences

	(1) LongDiff. GVA	(2) LongDiff. GDP
Log gross value added per capita,2006	0.01	
	(0.007)	
Log Glob. Comp Index, Δ2015/2006	1.32***	1.08***
	(0.318)	(0.308)
Log GDP percap,2006		-0.05***
		(0.016)
Constant	0.05	0.44**
	(0.076)	(0.168)
Observations	91	91
R-squared	0.204	0.219

Robust standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 13 Long differences, GVA per capita

When looking at long differences the changes of the Global Competitiveness Index shows a stronger association with GVA compared to GDP. This difference, is statistically not significant given the overlapping intervals on the two coefficients. In the case of gross value added per capita, no beta convergence effect is observable, for the long term, whereas it is apparent for GDP.

Chapter 5 Discussion of the results

5.1 Base models

The OLS have demonstrated that the levels of GDP per capita and the Global Competitiveness Index are correlated, when looking at the cross section data for 2012. First differences reveal that GDP growth and the changes of the index are associated both in terms of contemporaneous and lagged measures. In case of the first differences model, the goodness of fit measures reveal that the only-GDP model (changes of GDP per capita regressed exclusively on its past lagged values) are amended by including the same values for Global Competitiveness Index. The cumulative effects of the FD model shows the strongest association around the second and the third lag, meaning that changes of the GCI correlates with the subsequent, two-three year later changes of the GDP per capita. This can be quantified as follows: After one percent increase of, if no further change takes place, it is expected that GDP per capita increases by 0.3%, by the end of the second period. Consequently, growth is correlated in the short term with the changes of the Global Competitiveness Index, even after accounting for the effect of beta convergence. As displayed by first differences model, the proof for beta convergence is rather weak almost non-existent on the short term (up to five years). From this, however, it is difficult to draw any conclusions because the association and patterns can diverge over time. Thus, in one year the beta convergence might be strong and in the following one it may be insignificant, but in the panel and first difference setting, without fixing the initial year, these effects are not discernible from one another.

Fixed effect regression shows a strong correlation for the years covered by the sample. However, when adding year fixed effects, the relationship is less articulate. Additionally, fixed effect does not allow for beta convergence, which may distort the results. Long differences confirm the existence of a longer-term association by displaying following result: if the index values increase by one percent over the period 2006 to 2015, then it is expected that GDP per capita grows by 0.7 percent, while discounting the beta convergence effect. Nevertheless, long differences model only shows the difference between first and last year of the sample, but there is no information on the association for the in between period. On the other hand, beta convergence is much more remarkable in the long differences model, suggesting that the catching up effect need some time to occur. However, due to the methodological specificities of long differences the number of observations used is only 106 which makes it difficult to infer general conclusions.

First differences with two lags FD(2) was chosen, as the most adequate model, because it displays the strongest association while keeping the highest number of observations and accounting for beta convergence. (Due to the nature of first differences model with each additional lag, valuable observations are lost. Given the sample is relatively small, 1060 observations altogether, including a very high number of lags is not advisable.) Conducting robustness checks on the FD(2) model, only the rich versus poor country specification seems to remain significant. When it comes to the open and closed economy specification, the coefficients diverge significantly. In case of open economies, the log GCI does not seem to exhibit any correlation with log GDP per capita. This latter result might be explained by the composition of the sample used in the robustness checks, consisting of 70 country per year. Openness is principally captured by the components "Prevalence of trade barriers" and "Trade tariffs" of the global competitiveness index, which components can be grouped under the 6^{th} pillar, "Good market efficiency". This pillar is an essential element of competitiveness for countries being in the efficiency driven stage. Consequently, the presence of the countries currently in this stage, in the sample data used, can markedly influence the robustness of the association of GCI with the GDP per capita, with respect openness to the economy.

Due to the short period covered by the data, ten years is the longest term on which the relationship can be measured. Although for the most models results, either a contemporaneous or a lagged relationship is prevalent between the GDP per capita growth and the Global Competitiveness Index, this is not sufficient to infer causality. One of the reason is the potential presence of confounders, or variables that affect both GDP per capita growth and the changes of the index the same way. Hence, the real effect cannot be separated.

For most of the models the composition of the sample differs, due to the inconsistent availability of data for certain variables. which makes it difficult to extrapolate the results to all countries of the world. For instance, some of the least developed countries cannot provide the necessary data to construct the index, thus no inferences can be made on those group of countries. Consequently, there will be a consistent bias in the selection, distorting the results.

5.2 Including gross value added and the components of the index

In order to see how the above findings change by adding different left-hand-side variables, the regressions were repeated on the three most important model. (cross section OLS for 2012, first differences with two lags and long differences).

To identify components of the index that may affect its association with GDP per capita, three main pillars were tested, all three from different group stages of development (Institutions – Basic requirements, Goods market efficiency - Efficiency enhancers, Innovation - Innovation and Sophistication factors). Due to the small number of available variables, the observation count was only 65 on the balanced panel. Thus, no significant result could be drawn for the components "Institutions" and "Innovation". In the case of the pillar "Goods market efficiency", the dataset was large enough to have interpretable results. For cross section OLS and first differences, the coefficient on Goods market efficiency was not significantly different from that of the index, using the identical sample. However, this is not the case for long differences where the coefficient on Goods market efficiency was statistically not significant, while the index did show a strong significance on the same set of countries. Again, this difference of the coefficients of the two variables might be due to the very nature of the long differences model: by only using the first and the last year in the sample to determine growth, the observations which happen to have the higher correlation with GDP may be lost. Another explanation might lie in the index structure and methodology per se, corroborating the finding of Carvalho (2012) that the index performance can be explained solely with three pillars out of twelve, which are Macroeconomic Stability, Quality of Higher Education and Business Sophistication, from each three stage of development.

When it comes to testing alternative measures of productivity, gross value added (GVA) is considered as an adequate choice, since it is conceptually very similar to GDP. The cross sectional comparison of the two measures of the sample for does not show any significance for gross value added. However, for the first and long differences model, gross value added per capita is not statistically different from gross domestic product per capita. Consequently, although for the index the correlation with GDP provides its first source of validity (See Schwab, 2015), still the relationship with GVA might signal that it can be valid using other measure of productivity.

Chapter 6 Conclusion and policy relevance

In this paper, the relationship of productivity growth and the index was researched with cross sectional and panel data methods. The rational for the research is assessing the implications short term changes in the ranking and the pertaining scores: do they show any relationship with current productivity and can be used to infer future productivity growth? The results do affirm the existence of a relationship between the Global Competitiveness Index and competitiveness in terms of productivity, proxied by gross domestic product per capita. The research finds that contemporaneous and short term lagged cumulative associations are the strongest, between GDP per capita and the Global Competitiveness Index. However, this cannot be interpreted neither as causality between the country ranking in the index and competitiveness, nor as applied as a prediction for future growth.

Beta convergence is an important addition to the modelling of the relationship. It posits that poorer countries grow faster in the process of catching up to their more developed counterparts. (Sala-i-Martin, Barro, 1992) To account for that the initial level of GDP per capita was added as an explanatory variable, where permitted by the given model. The effect of beta convergence was insignificant on the short term, but the convergence effect was already more substantial over the longer term.

An essential element of the research should be emphasized: instead of static scores, the changes of the Global Competitiveness Index are incorporated into most models. This allows moving the research a slightly more towards causality, between the index and the GDP per capita as a measure of productivity. However, the methods used above during the analysis are not sufficient to infer any causal relationship between the two indicators. When using alternative measures of productivity, such as gross value added per capita, the relationship is still apparent between the index and the explanatory variable. There are some components of the index, e.g. Goods market efficiency which shows correlations with the GDP. However, the interpretation of this relationship is not straightforward, because the associations depend largely upon the composition of countries in the sample, given the specificities of the methodology of the constructing the Global Competitiveness Index.

When it comes to using these findings for policy, the results should be applied very cautiously. Although there is some apparent power to the index in revealing about the current and maybe the future productivity growth, that is not its original purpose. Rather, it is to use it to isolate the long-term determinants of growth Additionally, the detailed breakdown of the index, scores on specific indices and subindices can help policy makers identify more accurately the areas needing improvement and based on those, implement more effective policy actions.

Appendix

Exhibit 1 Base sample of 121 countries for cross sectional OLS regressions, covering the period 2010 and 2015

Albania
Algeria
Argentina
Armenia
Australia
Austria
Azerbaijan
Bahrain
Bangladesh
Belgium
Bolivia
Botswana
Brazil
Bulgaria
Burundi
Cabo Verde
Cambodia
Cameroon
Canada
Chad
Chile
China
Colombia
Costa Rica
Cote d'Ivoire
Croatia
Cyprus
Czech Republic
Denmark
Dominican Republic
Egypt, Arab Rep.
El Salvador
Estonia
Ethiopia
Finland
France
Gambia, The
Georgia
Germany
Ghana
Greece
Guatemala
Guyana
Honduras
Hong Kong SAR, China
Hungary
Iceland
India
Indonesia
Ireland
Israel
Italy
Jamaica
Japan
Jordan
Kazakhstan
Kenya
Korea, Rep.
Kuwait
Kyrgyz Republic
Latvia
Lebanon
Lesotho
Lithuania
Luxembourg
Macedonia, FYR
Madagascar
Malawi
Malaysia
Mali
Malta
Mauritius
Mexico
Moldova
Mongolia
Montenegro
Morocco
Mozambique
Namibia
Nepal
Netherlands
New Zealand
Nicaragua
Nigeria
Norway
Oman
Pakistan
Panama
Paraguay
Peru
Philippines
Poland
Portugal
Qatar
Russian Federation
Rwanda
Saudi Arabia
Senegal
Serbia
Singapore
Slovak Republic
Slovenia
South Africa
Spain
Sri Lanka
Swaziland
Sweden
Switzerland
Tanzania
Thailand
Trinidad and Tobago
Turkey
Uganda
Ukraine
United Arab Emirates
United Kingdom
United States
Uruguay
Vietnam
Zambia
Zimbabwe

Exhibit 2 – Restricted sample of 108 countries used for the panel data regressions

Albania	Greece	Netherlands
Algeria	Guatemala	New Zealand
Argentina	Guyana	Nicaragua
Armenia	Honduras	Nigeria
Australia	Hong Kong SAR, China	Norway
Austria	Hungary	Pakistan
Azerbaijan	Iceland	Panama
Bahrain	India	Paraguay
Bangladesh	Indonesia	Peru
Belgium	Ireland	Philippines
Bolivia	Israel	Poland
Botswana	Italy	Portugal
Brazil	Jamaica	Qatar
Bulgaria	Japan	Russian Federation
Burundi	Jordan	Singapore
Cambodia	Kazakhstan	Slovak Republic
Cameroon	Kenya	Slovenia
Canada	Korea, Rep.	South Africa
Chad	Kuwait	Spain
Chile	Kyrgyz Republic	Sri Lanka
China	Latvia	Sweden
Colombia	Lesotho	Switzerland
Costa Rica	Lithuania	Tanzania
Croatia	Luxembourg	Thailand
Cyprus	Macedonia, FYR	Trinidad and Tobago
Czech Republic	Madagascar	Turkey
Denmark	Malaysia	Uganda
Dominican Republic	Mali	Ukraine
Egypt, Arab Rep.	Malta	United Arab Emirates
El Salvador	Mauritius	United Kingdom
Estonia	Mexico	United States
Ethiopia	Mongolia	Uruguay
Finland	Morocco	Vietnam
France	Mozambique	Zambia
Gambia, The	Namibia	Zimbabwe
Georgia	Nepal	
Germany		

Exhibit 3 – One year changes of GDP per capita, 2011-2012

	Dependent variable: Change of log GDP per capita, 2011 - 2012		
	Levels added	Previous period change	Contemporaneous GCI
Log GDP per capita, 2011	-0.01***	-0.01***	-0.01***
	(0.002)	(0.002)	(0.002)
Change, log GDP per capita, 2010 - 2011		0.44***	0.43***
		(0.095)	(0.094)
Change, log GCI 2011 - 2012			0.19*
			(0.095)
Constant	0.10***	0.07***	0.08***
	(0.021)	(0.023)	(0.022)
Observations	121	121	121
Adj. R-squared	0.116	0.372	0.387

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Changes of GCI GDP per capita, cross section data 2011-2012
Note: Table contains log changes of GDP regressed on its levels, it previous period log change and contemporaneous effect of log GCI. Source: Own calculation, using World Bank, WEF data.

Exhibit 4 Panel data , first differences model, up to four lag

Dependent variable: log changes of GDP per capita	(0) No lag	(1) FD(1)	(2) FD(2)	(3) FD(3)	(4) FD(4)
Log GDP percapita = L,		0.41***	0.37***	0.38***	0.49***
		(0.055)	(0.068)	(0.056)	(0.089)
Log GDP percapita = L2,			-0.02	-0.04	-0.06
			(0.043)	(0.037)	(0.051)
Log GDP percapita = L3,				0.14***	0.09**
				(0.040)	(0.043)
Log GDP percapita = L4,					0.05
					(0.043)
Log values of Global Comp Index = D,	0.19***	0.14**	0.14**	0.15***	0.12**
	(0.074)	(0.056)	(0.064)	(0.054)	(0.054)
Log values of Global Comp Index = L,		0.17**	0.15***	0.13***	0.17***
		(0.069)	(0.054)	(0.043)	(0.056)
Log values of Global Comp Index = L2,			0.02	0.03	-0.03
			(0.064)	(0.038)	(0.043)
Log values of Global Comp Index = L3,				0.00	0.02
				(0.048)	(0.052)
Log values of Global Comp Index = L4,					-0.09**
					(0.043)
Log GDP percapita	-0.01***	-0.00***	-0.00**	-0.00	-0.00
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Constant		0.04***	0.05***	0.02	0.01
		(0.011)	(0.015)	(0.012)	(0.011)
Observations	972	864	756	648	540
Adjusted R-squared	0.262	0.401	0.392	0.296	0.344

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

First differences model
The table displays first differences regression on panel data, with differenced values of log GDP per capita as a left hand side variable and its lags, up to six and the differenced values of the log GCI as the right hand side variable, with the same number of lags. Year fixed effects are included SE is clustered. To account for beta convergence log GDP per capita is included
Source: Own calculation, using World Bank, WEF data

Exhibit 5 – Equation and regression table for model only including GDP as a right-hand side variable

$$\Delta \ln GDP = \alpha + \xi_1 \Delta \ln GDP_{t-1} + \xi_2 \Delta \ln GDP_{t-2} + \xi_3 \Delta \ln GDP_{t-3} + \xi_4 \Delta \ln GDP_{t-4} + \ln GDP_t + \varepsilon$$

Equation Cumulative effects, changes of GDP per capita included

	(1)	(2)	(3)	(4)
VARIABLES	FD(1)	FD(2)	FD(3)	FD(4)
Log GDP percapita	-0.00***	-0.00***	-0.00	-0.00
	(0.001)	(0.002)	(0.001)	(0.001)
Log GDP percapita = L,	0.43***			
	(0.049)			
Log GDP percapita = L2,		0.38***		
		(0.75)		
Log GDP percapita = L3,			0.51***	
			(0.57)	
Log GDP percapita = L4,				0.57***)
				(0.60
Observations	864	756	648	540
R-squared	0.389	0.386	0.289	0.327
Adjusted R-squared	0.383	0.379	0.279	0.316

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table Log GDP per capita cumulative differences, log GDP per capita included
Note: The table displays first differences regression, with GDP per capita and its cumulative differenced values up to four lags, as a right hand side variable. Year fixed effects are included and SE is clustered. All constant are significant (not displayed.)

Exhibit 7 - Sample for the panel of Innovation and Institution regressions (1st and 12th pillar)

Armenia
Australia
Austria
Azerbaijan
Bahrain
Bangladesh
Bolivia
Brazil
Bulgaria
Cambodia
Chad
Chile
China
Croatia
Cyprus
Czech Republic
Denmark
Dominican Republic
El Salvador
Finland
Georgia
Guatemala
Guyana
Hong Kong SAR
Hungary
Iceland
India
Indonesia
Ireland
Japan
Jordan
Latvia
Lesotho
Lithuania
Luxembourg
Macedonia, FYR
Madagascar
Malaysia
Mali
Mauritania
Mauritius
Mongolia
Mozambique
Namibia
Nepal
Nicaragua
Nigeria
Paraguay
Portugal
Qatar
Romania
Russian Federation
Slovenia
South Africa
Spain
Sweden
Taiwan, China
Trinidad and Tobago
Turkey
Ukraine
United States
Uruguay
Venezuela
Vietnam
Zimbabwe

Exhibit 8 – Sample for the panel of Goods market efficiency regressions (6th pillar)

Albania
Algeria
Argentina
Armenia
Australia
Austria
Azerbaijan
Bahrain
Bangladesh
Belgium
Bolivia
Botswana
Brazil
Bulgaria
Burundi
Cambodia
Cameroon
Canada
Chad
Chile
China
Colombia
Costa Rica
Croatia
Cyprus
Czech Republic
Denmark
Dominican Republic
El Salvador
Estonia
Ethiopia
Finland
France
Gambia, The
Georgia
Germany
Greece
Guatemala
Guyana
Honduras
Hungary
Iceland
India
Indonesia
Ireland
Israel
Italy
Jamaica
Japan
Jordan
Kazakhstan
Kenya
Korea, Rep.
Kuwait
Kyrgyz Republic
Latvia
Lesotho
Lithuania
Luxembourg
Macedonia, FYR
Madagascar
Malaysia
Mali
Malta
Mauritius
Mexico
Mongolia
Morocco
Mozambique
Namibia
Nepal
Netherlands
New Zealand
Nicaragua
Nigeria
Norway
Pakistan
Panama
Paraguay
Peru
Philippines
Poland
Portugal
Qatar
Russian Federation
Singapore
Slovak Republic
Slovenia
South Africa
Spain
Sri Lanka
Sweden
Switzerland
Tanzania
Thailand
Trinidad and Tobago
Turkey
Uganda
Ukraine
United Arab Emirates
United Kingdom
United States
Uruguay
Vietnam
Zambia
Zimbabwe

Exhibit 9 – Sample for the Gross value added outcome variable (91 countries)

Albania
Algeria
Argentina
Armenia
Australia
Austria
Azerbaijan
Bangladesh
Belgium
Bolivia
Botswana
Brazil
Bulgaria
Burundi
Cambodia
Cameroon
Canada
Chile
Colombia
Costa Rica
Croatia
Cyprus
Czech Republic
Denmark
Dominican Republic
Egypt, Arab Rep.
El Salvador
Estonia
Ethiopia
Finland
France
Gambia, The
Georgia
Germany
Greece
Guatemala
Guyana
Honduras
Hong Kong SAR, China
Hungary
India
Ireland
Italy
Jamaica
Jordan
Kazakhstan
Kenya
Korea, Rep.
Kyrgyz Republic
Latvia
Lesotho
Lithuania
Luxembourg
Macedonia, FYR
Madagascar
Mali
Mauritius
Mexico
Mongolia
Morocco
Mozambique
Namibia
Nepal
Netherlands
Nicaragua
Nigeria
Norway
Pakistan
Panama
Paraguay
Peru
Poland
Portugal
Russian Federation
Singapore
Slovak Republic
Slovenia
South Africa
Spain
Sweden
Switzerland
Tanzania
Thailand
Trinidad and Tobago
Turkey
Uganda
Ukraine
United Kingdom
Uruguay
Zambia
Zimbabwe

Exhibit 10 – OLS2012, FD(2) LD regressions for the first pillar of the index Innovation

$$\ln GDPpcap_{2012} = \alpha + \delta Pillar2012 + \varepsilon$$

Equation Cumulative effects, changes of GDP per capita included

	(1)	(2)
	Log GDP per capita, 2012	
Log Institutions,2012	0.62	
	(0.706)	
Log Global Comp Index, 2012		6.37***
		(0.358)
Constant	8.56***	0.16
	(1.012)	(0.543)
Observations	65	65
R-squared	0.013	0.786

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

: Log values Institution pillar vs. log values global competitiveness index, cross section OLS, 2012

The regression of model described by the above equation tells us that the fist pillar does not have a significant relationship with the GDP per capita. When checking the same regression for the index, the association is very similar to that of the full panel. In the first differences model with two lags, there is no significant effect of neither of them, which is probably due to the very low number of observations.

$$\Delta \ln GDPpcap_t = \alpha + \xi_1 \Delta \ln GDPpcap_{t-1} + \xi_2 \Delta \ln GDPpcap_{t-2} + \beta_0 \Delta \ln Pillar_t + \beta_1 \Delta \ln Pillar_{t-1} + \beta_2 \Delta \ln Pillar_{t-2} + \ln GDPpcap_t + \varepsilon$$

Equation First differences model (FD), Pillar (index component)

	(1)	(2)
	Log changes of GDP per capita	
Log values of GDP per capita	-0.00	-0.00
	(0.002)	(0.002)
Log values of GDP per capita = L2,	0.49***	0.47***
	(.078)	(0.088)
Log Goods market efficiency pillar = L2,	0.04	
	(0.052)	
Log index =L2		0.26*
Constant		(0.133)
	(0.018)	(0.018)
Observations	455	455
R-squared	0.434	0.448

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table First differences model (FD), Pillar (index component)

The long differences model doesn't show any significant coefficients for the changes of the Global Competitiveness index and changes of GDP per capita.

$$\Delta \mathrm{lnGDPpcap2015/2006} \ = \alpha + \ \beta lnGDPpcap2006 + \ \delta \Delta lnGoods2015/2006 + \varepsilon$$

Equation Long differences, Pillar (index component)

\

	(1)	(2)
	Dependent variable: Δ Log GDP per capita 2015/2006	
Log values of GDP per capita	-0.06**	-0.05*
	(0.026)	(0.029)
Log values of GDP per capita = L2,	0.29	
Log Goods market efficiency pillar = L2,	(0.211)	
Log index =L2		0.85
		(0.552)
Constant	0.75***	0.64**
	(0.259)	(0.286)
Observations	65	65
R-squared	0.151	0.181

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

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