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Thinking ahead for Europe

Institutions and Growth in Europe

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and Beatrice Pierluigi

No. 421 / April 2016

Abstract

This paper provides empirical evidence in support of the view that the quality of institutions is an important determinant of long-term growth of European countries. When also taking into account the initial level of GDP per capita and government debt, cross-country institutional differences can explain to a great extent the relative long-term GDP performance of European countries. It also shows that an initial government debt level above a threshold (e.g. 60-70%) coupled with institutional quality below the EU average tends to be associated with particularly poor long-term real growth performance. Interestingly, the detrimental effect of high debt levels on long-term growth seems cushioned by the presence of very sound institutions. This might be because good institutions help to alleviate the debt problem in various ways, e.g. by ensuring sufficient fiscal consolidation in the longer-run, allowing for better use of government expenditures and promoting sustainable growth, social fairness and more efficient tax administration. The quality of national institutions seems to enhance the long-term GDP performance across a large sample of countries, also including OECD countries outside Europe. The paper offers some evidence that, in the presence of good institutions, conditions for catching-up seem generally good also for euro-area and fixed exchange rate countries. Looking at sub-groupings, it seems that sound institutions may be particularly important for long-term growth in the countries where the exchange rate tool is no longer available (and where also sovereign debt is high), and less so in the countries with flexible exchange rate regimes. However, this result is preliminary and requires further research.

The empirical findings on the importance of institutions are robust to various measures of output growth, different measures of institutional indicators, different sample sizes, different country groupings and to the inclusion of additional control variables. Overall, the results tend to support the call for structural reforms in general and reforms enhancing the efficiency of public administration and regulation, the rule of law and the fight against rent-seeking and corruption in particular.

Key words: quality of institutions and real growth, public governance, structural reforms, public debt, panel estimates

JEL Classification: O43, C23, E02, H63

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ISBN 978-94-6138-516-1
Available for free downloading from the CEPS website (www.ceps.eu)
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Institutions and Growth in Europe

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CEPS Working Document No. 421 / April 2016

Non-technical summary

During the past 20 years, European countries have experienced very different growth performances. A significant part of these differences cannot be justified by differences in the initial levels of GDP per capita and the related catching-up potential. The ECB argued in its Economic Bulletin (ECB, 2015) that the quality of domestic institutions and governance has a positive impact on economies' per capita income growth and that a lack of real convergence can be "related to several factors, notably weak institutions, structural rigidities, weak productivity growth and insufficient policies to address asset price booms".

Against this background, this paper investigates whether initial levels of the quality of institutions and public debt can help to explain the different long-term growth performances in Europe and why real convergence in the euro area seems to have been lagging behind. To answer this question, the paper builds on two strands of empirical analysis on the determinants of long-term growth of a country: first the impact of the quality of institutions and second the role of high debt in affecting GDP growth. The benchmark model links long-term GDP growth with the initial levels of the quality of institutions, government debt (above a threshold) and an interaction term between these two explanatory variables.

Long-term growth is defined as the 15-year average per capita output growth. While in growth theory this time span may not be sufficient to be qualified as "long-term" growth, in this paper we consider it sufficiently long to derive some robust conclusions for advanced economies. The quality of institutions is based on a composite index including four measurable governance indicators (taken from the World Bank): rule of law, regulatory quality, government effectiveness and control of corruption (in the paper termed "institutional delivery"). These indicators try to capture how well national administrative and governmental institutions that determine the environment for economic activities are able to deliver a level playing field for all economic actors, prevent rents extraction and waste of resources and ensure sound economic incentives to invest, innovate, and provide public goods. Public debt enters in the benchmark model as a dummy variable, which takes the value of one only when public debt is above certain thresholds.

The benchmark model is estimated for EU countries, EU plus non-EU OECD and for two sub-groups of countries: countries with fixed exchange rate regimes and those belonging to the euro area, and countries with flexible exchange rate regimes. Results are also shown for the

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Without implicating them, very useful comments were received (in alphabetical order) from Daron Acemoglu, John Christopher Bluedorm, Kevin Cardiff, Cristina Checherita-Westphal, Joao Nogueira Martins, Athanasios Orphanides, Andre Sapir and Jesus Fernandez-Villaverde. The views expressed in this paper are those of the authors and they do not necessarily coincide with those of the European Central Bank or the Eurosystem.

EU excluding Greece and for the EU excluding the Central and East European countries (CEECs), which joined the EU in 2004 and 2007, given the very different levels of institutions and debt in the two groups of countries. The sample period includes annual data from 1995 until 2017. Given that the target variable - potential output growth - includes 15 years of data, the explanatory variables run from 1995 until 2002. The econometric approach consists of pooled mean estimates, which account for autocorrelation of errors across time, as the 15-year average per capita output growth series are overlapping. The last 15-year average per capita output growth, e.g. 2002-17, includes two years of forecasts taken from the European Commission database.

Various robustness exercises have been carried out to enhance robustness of the results and partly also to control for the risk of reverse causality, for example the use of different proxies for institutional quality or the introduction of additional control variables in the equation. Moreover, the fact that the institutional variable enters the equation as initial condition at time t, to explain the subsequent 15-year average per capita GDP growth, may also tend to alleviate the problem of reverse causality. To test for the possibility that both *institutional delivery* and long-term growth are affected by deeper country-specific characteristics, the estimates are also carried out with 2-SLS instrumental variables, using legal origins dummies as instruments for institutional delivery. This approach confirms the results of the benchmark model, despite the fact that instruments are not always significant. This supports the view that causality seems indeed to run from institutions to long-term growth.

The findings of the paper tend to support the view that the quality of institutions is an important determinant of long-term growth. The results seem particularly important for countries where institutional delivery is below or around the EU average and initial public debt is above a threshold (e.g. 60% or 70%). To the extent that causality is indeed running from institutions to subsequent long-term growth, such countries could experience significantly higher per capita GDP growth if their institutions were improved. Interestingly, the presence of very sound institutions appears able to offset the detrimental effect of high debt on long-term growth. While this result needs to be treated carefully as it is driven by rather few observations, it might suggest that debt thresholds above which debt levels are detrimental for growth are not the same across countries, but could be endogenous to the quality of public institutions. A possible narrative consistent with these findings could be that sound institutions may help alleviate the debt problem via various channels. For example, good institutions may i) allow for a better (potentially growth-enhancing) use of government expenditures financed by debt (e.g. the Scandinavian example); ii) promote stronger growth via sound structural policies, iii) promote social fairness and allow for more efficient tax administration, thereby reducing the economic and social costs associated with high debt and/or iv) ensure that episodes of large increases in debt are followed by sufficiently strong consolidation policies in subsequent years. Empirical analysis testing for the above channels is beyond the scope of this paper and left for future research.

While the results hold across different group of countries, it appears that the conditions for real convergence are also generally good for the group of euro area (EA) and fixed exchange rate countries (for the short fixed exchange rate group). At the same time, the quality of institutions seems particularly important for this group. While these results are preliminary and require further research, this could reflect the fact that sound institutions – and the associated policies – are helpful for compensating for the lack of exchange rate tools as adjustment and disciplinary devices, supporting the view that improvements in institutions

and the associated structural reforms are particularly important for euro-area countries to reap the full benefits of monetary union.

The benchmark model is changed in several ways to check the robustness of the results. First the results are assessed against different debt thresholds (corresponding to the EU average, the Maastricht threshold and the EA average); second, the model is augmented with different control variables, which are typically included in the growth literature (educational attainment, savings rate, government expenditure, etc.); third, other measures of institutional quality are used as a proxy for institutional delivery, which allow for extending the sample period considered by 20 years, i.e. advancing the starting date from 1995 to 1975. These changes continue to support the evidence that institutional delivery is a critical determinant of long-term growth in Europe; however the significance of debt thresholds turns out to be less robust to the above changes.

Various robustness exercises are also reported by using different measures of long-term growth and different time-spans. These exercises also show that the estimates obtained with the benchmark model are relatively robust to changes in specifications.

There are of course many factors, which are not or only partially included in the institutional variables used here, that can enhance longer-term growth. For example, macroeconomic stability, prudent fiscal policies, an efficient set-up of universities, school and dual education systems, strong incentives for investment in human and real capital, a high degree of flexibility and openness in product and labour markets, well-capitalised and supervised financial institutions, efficient insolvency frameworks and conditions conducive to the efficient use of capital and labour in the economy, including via economic integration within the EU. The results of this paper are broadly consistent with the view that the World Bank (or other) indicators measuring the quality of institutions cover key factors and mechanisms, which also determine the probability that governments and societies in the future support sound policies and reforms in these areas, enhancing long-term growth. The link between institutional quality and the probability of supporting sound policies and reforms in Europe that enhance long-term growth, however, has not been tested explicitly in this paper. It is left for further research.

1. Literature overview

European countries continue to experience quite different long-term GDP growth rates, even when accounting for different catching-up potentials related to the initial levels of per capita GDP. In focusing on the euro-area countries, the July 2015 issue of the Economic Bulletin of the ECB summarises its assessment of the real convergence and the (lack of) catching-up as follows:

> The global financial crisis that started in 2008 has showed that some countries participating in Economic and Monetary Union (EMU) had severe weaknesses in their structural and institutional set-up. This has resulted in a large and protracted fall in real per capita income levels in these countries since 2008. While there has been real convergence in the European Union (EU) as a whole since 1999 owing to the catching up of central and eastern European (CEE) economies, there has been no process of real convergence among the 12 countries that adopted the euro in 1999 and 2001.

Against this background, this paper specifically investigates the role of two initial conditions in explaining long-term growth differences: the quality of national public and economic institutions and the level of public-sector debt. The various specifications used can be

considered part of the vast empirical analysis testing the notion of conditional convergence, i.e. the relationship between growth rates and initial conditions.

The paper provides evidence that is consistent with the view that conditions for real convergence are in principle good for countries that no longer have the nominal exchange rate tool (i.e. the group of euro-area and fixed exchange rate countries). At the same time, the quality of institutions appears very important for long-run growth in general and seems particularly important for this group of countries and/or for countries with initial debt above a certain threshold.

The crucial role of sound and efficient institutions – sometimes also referred to as good governance – in explaining long-run growth has been formalised in a number of contributions in the early 2000s, showing that countries with weaker institutions find it harder to sustain growth and are more vulnerable to experiencing periods of crisis and stagnation (Acemoglu, Johnson, & Robinson, 2001; 2002). Acemoglu et al. (2004) show, by using a number of historical episodes, how institutions are able to determine the incentives of, and the constraints on, economic actors and shape long-term economic outcomes. In Acemoglu et al. (2004) economic institutions are identified with the structure of property rights and the access to economic resources. Thus, good economic institutions are those that provide security of property rights and relatively equal access to economic resources to a broad cross-section of society. The analysis of historical episodes also shows that strong institutions, democracy, transparency and political stability bring about reduced output volatility.

In this paper, we use a definition of economic institutions that is similar to that in Acemoglu et al. (2004). It is based on four measurable governance indicators (taken from the World Bank Indicators): rule of law, regulatory quality, government effectiveness and control of corruption. These indicators try to capture how the economic structure is able to deliver a level-playing field for all economic actors, ensure that rents extraction and waste of resources is limited and sound economic incentives are in place for encouraging people to invest, innovate, save, solve problems of collective actions and provide public goods.

As well emphasised by Blanchard & Wolfers (2000), when dealing with institutional variables, the problem of their endogeneity to macroeconomic outcomes arises, also on account of the fact that these variables have been generally measured ex-post. Hall & Jones (1999) also stress the endogenous nature of institutions, arguing that institutions might depend themselves on the level of output per worker in an economy. This implies that any research involving institutional variables require a significant amount of robustness checks. In this paper, we use 2-SLS instrumental variables, using legal origins dummies as instruments for institutional delivery, following La Porta et al. (1999) as well as other robustness checks, i.e. different measures of institutions and the inclusion of other structural control variables. By using legal origins, we test the hierarchy of institution hypothesis (Acemouglu et al., 2004), according to which while economic institutions affect economic performance, they are themselves both directly and indirectly influenced by political institutions. Our approach is similar to Eicher & Leukert (2009), who use a set of political institutions variable as instruments for economic institutions. However, our instruments do not suffer from an ex-post measurement bias, as they refer to the legal origins of a country. In a similar vein, Hall & Jones (1999) had used location and language differences to instrument institutions and showed that differences in output per worker in a sample comprising 127 countries (OECD and developing) are driven by differences in institutions and government policies, which they refer to as *social infrastructure*.

However, contrary to the above-mentioned works, our approach does not aim to explain differences in level but in the growth rate of per capita GDP. When limiting the attention to Europe, there has been a relatively large amount of empirical work on the convergence across countries; however, not much attention has been devoted to differences in economic institutions as an explanatory factor. For example, substantial empirical work has been done to assess the convergence of transition economies of Eastern European countries (Rapacki & Próchniak, 2009), based on a traditional set of macroeconomic and structural variables. Other work has focused on the identification of "convergence clubs", i.e. country groups within the EU which have in common the level of real income per capita (Borsi & Metiu, 2013), derived from a neoclassical growth model augmented with endogenous technological progress. Borsi & Metiu (2013) found that regional linkages seem to play a significant role in determining the formation of convergence clubs and that euro-area countries belong to distinct subgroups; thus clustering is not necessarily related to EMU memberships. Already in 2008, the European Commission (2008) had pointed out that the catching-up processes have been somewhat lower in EMU than outside it, even when accounting for differences in the initial levels of GDP per capita. Most recently, by means of a counterfactual analysis, using synthetic control methodology, Fernandez & Garcia Perea (2015) argued that the adoption of the euro did not produce the expected permanent increase in the GDP per capita growth rate. While their model does not explain why this happened, the authors refer to the lack of a rise in intra trade and to the lack of policies to boost productivity as potential causes.

However, empirical work on the institutional determinants of longer-term growth performance of euro-area countries has been so far relatively limited. This is mainly due to the fact that the euro-area history is new, and 15 years of monetary union may seem rather short for any long-term growth theory to be properly applicable. This also implies that work on growth differentials and governance in the euro area has so far been more of a narrative nature. For example, Fernandez-Villaverde et al. (2013) discuss an impressive set of qualitative and anecdotal evidence in some euro-area countries on the interaction of euro-area membership and the loosening of financial and borrowing constraints, and related disincentives for governments to reform. Their analysis does not include an attempt to provide empirical estimates on the impact of deep-rooted institutional differences across countries.

Much wider, however, is the empirical literature linking GDP growth performance to structural variables in the OECD countries, in which typically each factor of a production function is directly or indirectly related to institutional or structural variables. For example, Bassanini et al. (2001) show how the accumulation of physical and human capital and policy conditions (e.g. R&D activity) affects growth. Similarly, Barnes et al. (2013) report estimates for all OECD countries where GDP per capita growth and its supply-side determinants are affected by a wide range of structural policy. These estimates show large impact of labour and product market regulations, tax systems, education, R&D and FDI (foreign direct investment) policies on real GDP per capita. Our paper is complementary to the above-mentioned literature. It focuses on the explanatory power of a parsimonious number of initial conditions on the subsequent long-term GDP per capita growth performance. This is done by looking at eight years of initial conditions, from 1995 to 2002, in terms of starting level of per capita GDP, government debt and quality of economic and public institutions, and for each point in time the subsequent 15-year per capita GDP growth performance. Moreover, this paper adds a new dimension to the empirical literature on long-term growth as it investigates the interaction between indebtedness and the quality of institutions.

The link between debt and structural indicators has already been analysed from a different perspective, e.g. by conditioning debt sustainability analysis on a set of structural indicators (Wyplosz, 2007). Papers linking debt with growth have been numerous. Chalk & Tanzi (2002) highlight different channels through which debt can affect growth. In particular, high public debt can put upward pressures on interest rates, which reduces private investment and thus growth; higher debt is *ceteris paribus* associated with higher expected future taxes, which can reduce expected after-tax returns on investment. Most recently, empirical papers linking debt with growth found thresholds values above which debt can become harmful for GDP growth (Baum, Checherita-Westphal, & Rother, 2013). These threshold effects, which are estimated to occur between 70-90% of GDP depending on the sample used and the definition of debt, have been found to be significant not only in the case of public debt but also for private debt (Cecchetti, Mohanty, & Zampolli, 2011).

Contrary to Wyplosz (2007), this paper does not address the issue of debt sustainability per se, but it shows that in case of a relatively low quality of domestic institutions a high debt level tends to be associated with lower long-term growth. It also does not search for endogenous threshold values due to the fact that the time dimension is relatively limited (i.e. eight years), which implies little country-specific variability of the debt series. The paper is organised as follows. Section 2 describes the data. Section 3 presents the empirical models and discusses the results. Section 4 presents a number of variants of the benchmark model and section 5 includes additional robustness check. Section 6 concludes.

2. Data analysis

The empirical analysis is based on annual data, covering the EU countries.[1] The key variables of interest are: GDP per capita, government debt and an aggregate measure of quality of economic institutions. These initial variables are used to explain the potential GDP per capita growth over the subsequent 15-years. The aggregate measure of economic institutions comes from the Worldwide Governance Indicators (WGI) database published annually by the World Bank (Kaufmann, Kraay, & Mastruzzi, 2010).[2] The full database contains six governance indicators: Voice and Accountability, Political Stability and Absence of Violence, Government Effectiveness, Regulatory Quality, Rule of Law and Control of Corruption. This paper focuses on the average of the latter four, which captures the quality of economic and administrative institutions, referred to as *institutional delivery* or institutional quality[3], while the first two indicators are related to the political setting. The remaining variables (Real GDP, potential GDP, population and government debt) are taken from the European Commission database (November 2015).[4]

Figure 1 shows the level of per capita GDP (x-axis) in 1999, plotted against the 15-year average potential GDP per capita growth (y-axis). The figure distinguishes between the early euro area

[1] Luxemburg is excluded from the sample, as GDP per capita is not a meaningful variable, given the very large number of employees commuting cross-borders.

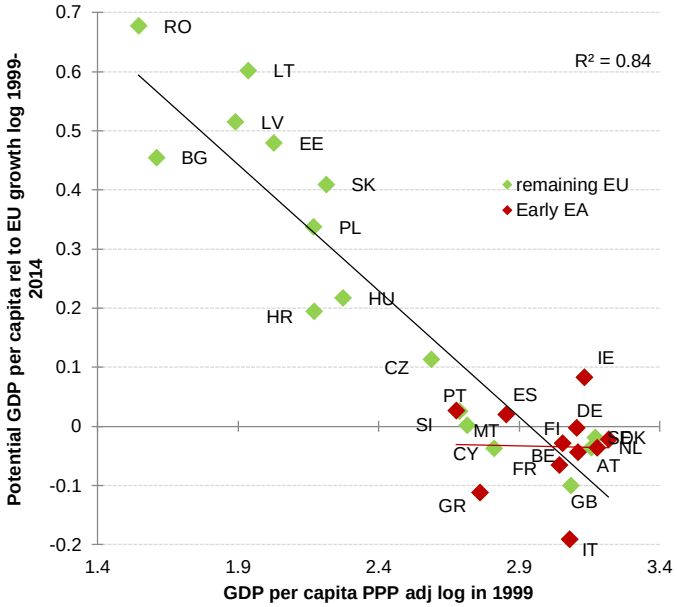
[2] http://info.worldbank.org/governance/wgi/index.aspx

[3] See J. Helliwell et al. (2014), "Good Governance and National Well-being: what are the linkages?", OECD Working Papers on Public Governance, No. 25, OECD Publishing, Paris.

[4] http://ec.europa.eu/economy_finance/eu/forecasts/2015_autumn_forecast_en.htm For EU-28, data are available from 2001 to 2017. For EU-27 excluding the latest entrant Croatia, data from 1998 onwards are available.

group (i.e. the countries that joined the euro area up to 2001 – early EA) and the rest of the EU. With an R^2 of 0.85, one can conclude that initial GDP conditions are able to explain a great deal of the variability in the subsequent potential GDP per capita growth. This is in line with the expectations that countries with lower income per capita would growth faster than countries with higher income per capita. Stronger GDP growth in the period 1999-2014 in the rest of the EU can also be associated with the impact of the EU membership which took place in 2004 (Campos, Coricelli, & Moretti, 2014).

Figure 1. Catching-up effects (real GDP per capita in 1999 and potential GDP per capita growth in 1999-2014)



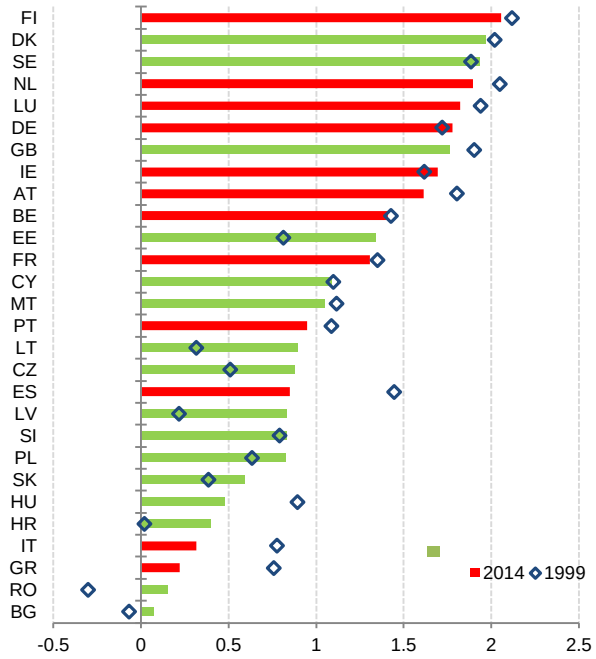
Note: In red early EA countries (i.e. countries that joined the euro area until 2001), in green other EU countries.
Source: ECB's computation on European Commission data.

However, the figure shows that certain countries have fallen out from this simple prediction model. For example, Greece, Portugal, Slovenia, Cyprus, Italy, Bulgaria and Croatia show particularly high negative residuals while the Baltic countries, Romania, Slovakia and Ireland were growing very fast compared to their initial GDP level.

In this paper the simple catching-up model shown in Figure 1 is extended by considering institutional delivery and the level of public debt. Figure 2 shows the level of the institutional delivery indicator across the EU in two periods of time: 1999 and 2014. This indicator refers to the World Bank's 215 country sample, where a positive value means good institutional delivery. Its statistical distribution follows a standard normal random variable, i.e. with zero mean, unit standard deviation, and ranges approximately from -2.5 to 2.5. In this paper, we centre this indicator to the EU27 sample average in 1996. Figure 2 shows that there is a large variability across the EU countries in terms of institutional quality, and that, as expected, richer countries are enjoying higher institutional delivery. Interestingly, however, the figure shows a very large variability inside the early EA group (red bars) despite much more limited per capita GDP differences across this group of countries. Finally, the figure shows also that during the past 15 years many of the early EA group (with the strongest drop in Greece, Italy and Spain) saw a worsening of the institutional delivery indicator. The analysis of the evolution of institutional delivery is presented in Annex 1 with a diff-in-diff computation. This

picture seems consistent with the findings in Fernandez-Villaverde et al. (2013), which emphasises the disincentives to implement reforms after the stage 3 of EMU.

Figure 2. Institutional delivery indicator (1999 vs. 2014)

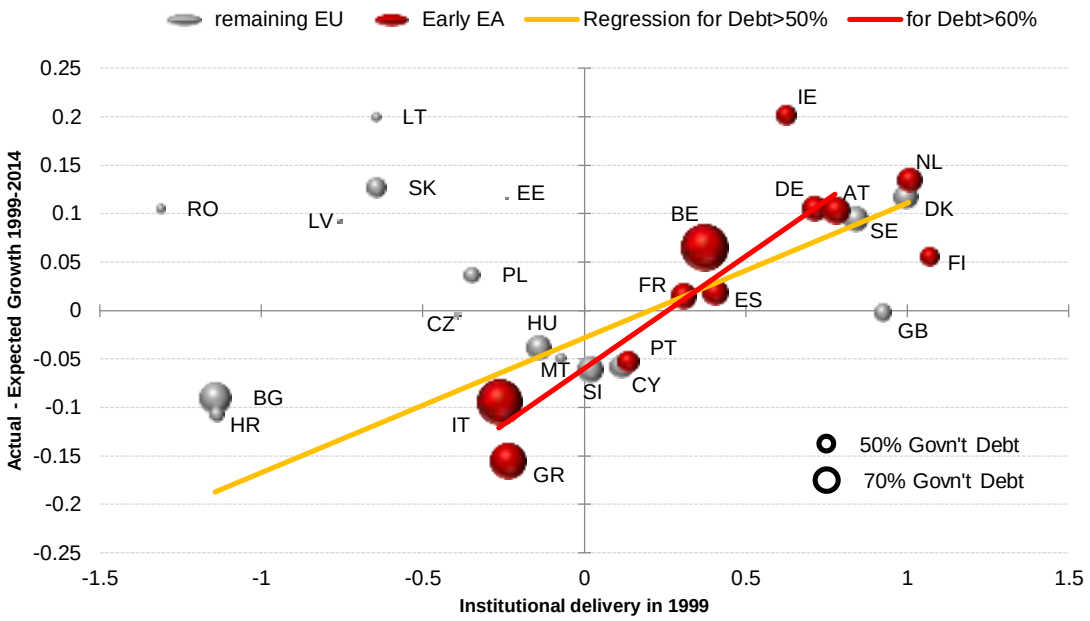


Note: Average of four indicators: Government Effectiveness, Regulatory Quality, Rule of Law and Control of Corruption. In red early EA countries and in green rest of EU.

Source: Authors' computation on WDI data.

Figure 3 puts together the residual from the simple catching-up model (Figure 1) and the institutional delivery in 1999, taking into account the level of the government debt. This is done by representing the size of countries' circles according to their government debt-to- GDP ratio. Figure 3 shows that the quality of institutions seems to matter most, in the sense that it is associated with subsequent relative GDP growth, for relatively high-debt countries, i.e. for countries with government debt at least above 50% of GDP. When focusing on the euro-area countries (red dots), a clear positive relationship emerges between the institutional quality and the residual from the simple catching-up model. This figure seems to indicate that institutional quality and government debt (above a certain level) could be two explanatory variables of the long-term GDP performance in the EU, and in particular in the euro area.

Figure 3. Institutions, debt and country-groups



Source: ECB's computation on EC and World Bank data.

Before testing econometrically the relationship between the variables plotted in Figure 3, Table 1 provides a summary of the key indicators at play. The table distinguishes between five groups of countries: the whole EU, the countries with government debt higher than the 60% Maastricht threshold, the countries with government debt lower than the 60% Maastricht threshold, the Early EA, which refers to the countries that joined the euro area between 1999 and 2001; and the transformation countries, which refers to the Central and East European countries which joined the EU in 2004 and 2007. The table shows un-weighted averages across the different groups of the cumulated potential per capita GDP growth in 1999-2014, the level of GDP per capita in 1999, the institutional delivery in 1999, 2007 and 2014 and government debt in 1999.[5] Across the variable reported it is interesting to note that the higher debt level in 1999 has been associated with lower per capita potential growth. It also shows that institutional delivery decreased not uniformly across the various groups of countries. It has been constantly falling in the high-debt countries and in the early EA, constantly improving in the transformation countries and falling since 2007 in the low-debt countries.

Table 1. Key summary statistics of the indicators used in the regression analysis[6]

	EU	Debt<60$_{1999}$	Debt>60$_{1999}$	Early EA	Transformation countries
Pot. GDP per capita PPP adj growth$_{1999-2014}$	80.24	95.04	55.91	49.02	126.05
GDP per capita in thsd PPPadj EUR$_{1999}$	15.65	14.15	18.72	20.49	8.81
WGI Delivery$_{1999}$	0.034	0.018	0.177	0.445	-0.624
WGI Delivery$_{2007}$	0.091	0.058	0.157	0.359	-0.427
WGI Delivery$_{2014}$	0.062	0.011	0.097	0.271	-0.376
Government Debt % GDP$_{1999}$	52.41	37.67	76.01	69.13	32.38
Observations$_{1999}$	27	16	10	11	11

Source: ECB's computation on European Commission and World Bank data.

[5] There is no European Commission data on the level of Croatian Government Debt in 1999.
[6] General government debt data are reported in Annex 2.

3. The empirical model and estimation results

3.1 The EU sample and the Maastricht debt threshold

The correlations figure shown in the previous section (Figure 3) seems to indicate that the quality of institutions may be more important to explain the long-term GDP performance in the early EA group than in the rest of the EU. The analysis has also shown that there is a high correlation between levels of debt and early euro-area membership. Against the above evidence, this section tests the validity of a parsimonious empirical model capturing the linkages between the quality of institutions and level of debt.

The estimated benchmark model takes the following specification:

$$(1) \qquad \Delta y_{c,t} = \alpha + \beta_y\, y_{c,t} + \beta_D D_{c,t} + \beta_I I_{c,t} + \beta_{DI} D_{c,t} I_{c,t} + \varepsilon_c$$

where:

$\Delta y_{c,t}$ is the 15-year average GDP per capita growth computed starting at time t (i.e. log change of potential purchasing power (PPS) adjusted GDP per capita) with t running from 1995 to 2002 for country c.

$y_{c,t}$ is the log starting level of the PPS adjusted GDP per capita at time t for country c.

$D_{c,t}$ is a dummy, at time t for country c, which takes the value of 1 if government debt is greater than a certain threshold. In our benchmark model we assume that the threshold is 60% of GDP (Maastricht threshold).

$I_{c,t}$ measures the institutional delivery at time t for country c, the index is centred at the EU average level and we apply a 3-year centred moving average. This is done to include as much as possible back data, which prior to 2002 where available on a biannual basis.

$D_{c,t} I_{c,t}$ is the interaction between the latter two indicators.

Given that the last starting data point is 2002, the corresponding GDP growth interval, i.e. 2002-17, includes two years of forecast, which is taken from the European Commission. For Bulgaria, debt data are available from 1997 and for Croatia, debt data are available from 2001 onwards.

As a result, the panel consists of 208 data points (25*8 + 6 + 2). Given that the panel's GDP growth periods are overlapping, to account for autocorrelation of errors across time, we use a pooled OLS regression with standard errors clustered across time. The choice of the pooled OLS regression instead of a country-fixed effect model is due to the use of the country-specific institutional delivery variable, which contains very little variability between 1995 and 2002 and plays the role of a country-specific constant.

We estimate the model by using both ordinary least squares and 2-SLS instrumental variables. The latter method is used to account for the possibility that deep cultural, legal and political differences are behind different economic institutions (Acemoglu, Johnson, & Robinson, 2004; 2005). Thus we decide to use the approach of La Porta et al. (1999), where "legal origin" dummies are used as instruments for the economic variables.[7] In view of the presence of the interaction term, two instrumental equations are estimated in the first step:

[7] In La Porta et al. (1999) countries are grouped according to English (CY, IE, UK), French (MT, BE, ES, FR, GR, IT, NL, PL), German (AT, DE), Soviet (EE, LT, LV, SI, SK, BG, CZ, HR, HU, PL, RO) and Scandinavian (FI, DK, SE) legal origins.

$$(2) \qquad I_{c,t} = \gamma_0 + \gamma_1 y_{c,t} + \gamma_1 D_{c,t} + \gamma_2 LO_{c,t} + \gamma_3 D_{c,t} LO_{c,t} + \epsilon_c$$

$$(3) \qquad D_{c,t} I_{c,t} = \delta_0 + \delta_1 y_{c,t} + \delta_1 D_{c,t} + \delta_2 LO_{c,t} + \delta_3 D_{c,t} LO_{c,t} + \epsilon_c$$

where LO stands for "legal origin". In the second step the fitted values of $I_{c,t}$ in equation (2) and of $D_{c,t} I_{c,t}$ in equation (3) are plugged in the original equation (1).

Table 2. Estimation output of equation (1)

15-year average per capita potential growth		
Explanatory variables	OLS	2SLS
Log GDP (PPP)	-0.589***	-0.611***
	(0.0386)	(0.0413)
Institutional delivery	0.0951***	0.116***
	(0.0317)	(0.0394)
(Debt>60)	-0.0394*	-0.0357*
	(0.0197)	(0.0186)
(Debt>60) x Institutional delivery	0.131***	0.123***
	(0.0283)	(0.0289)
Constant	2.127***	2.181***
	(0.0988)	(0.105)
Observations	*208*	*208*
R-squared	*0.911*	*0.910*

Robust standard errors in parentheses

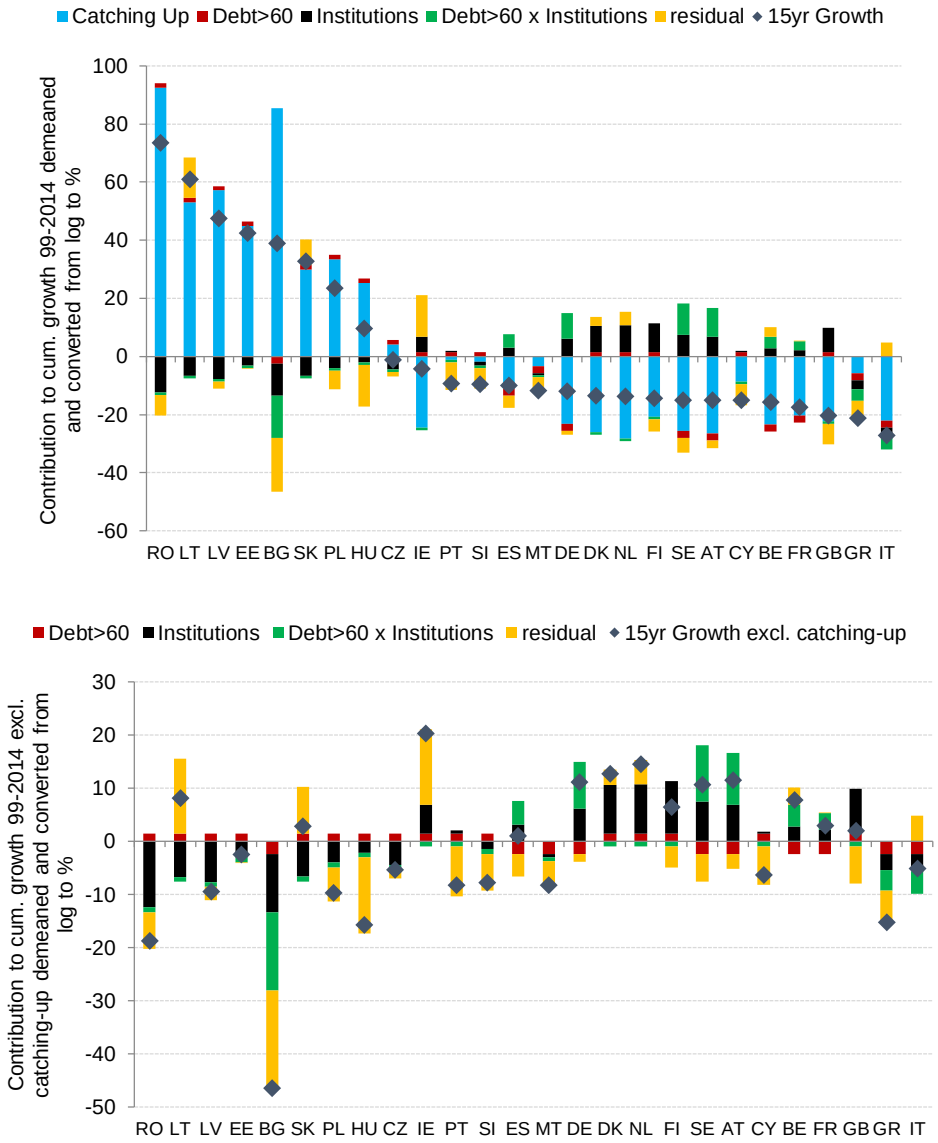
**** p<0.01, ** p<0.05, * p<0.1*

The estimation results are shown in Table 2.[8] The table shows that the catching-up effect, i.e. the impact of the initial level of GDP per capita, is highly significant in both regressions and, as expected, it indicates that higher initial GDP per capita is associated with subsequently lower long-term per capita GDP growth. Moving from one estimation method to another does not impact the significance nor the size of the coefficient. The institutional delivery indicator is significant and positive, meaning that stronger quality of institutions is correlated with subsequent higher per capital long-term GDP growth. This result also holds for both estimation methods. Debt dummies are always negatively significant: higher government debt levels reduce long-term GDP per capita growth irrespective of the estimation method. Interestingly, the 60% threshold used for the debt dummy appears significant. The interaction terms are positively highly significant. When looking at the debt dummy and at the interaction term jointly, one can conclude that in the presence of high debt, an improvement of institutions is associated with higher growth potential, and conversely, a deterioration is associated with lower growth potential. This conclusion holds across both estimation methods. The main takeaway of this exercise is that countries with high debt and low institutional delivery would be significantly better off if they were able to increase the quality of their institutions. For high levels of institutional delivery, the model suggests that high debt is not a problem. This is the

[8] Annex 3 reports step 1 estimates of the 2-SLS.

result of the inclusion in the sample of countries that had both high debt and very good institutional delivery between 1995 and 2002 and robust growth afterwards (e.g. Belgium).[9]

Figure 4. Contributions to the cumulative potential GDP per capita growth – estimated equation (1)



Source: Authors' computation on European Commission and World Bank data.

Figure 4 visualises the regression result of the first column of Table 2. The indicators are demeaned and transformed from log to percentages for better readability. The results are shown for the year 1999 (explanatory variables) and for the per capita GDP growth in 1999-2014. The figure shows in the upper panel all the contributions and in the lower panel the contribution of institutional delivery, debt and the interaction term on the per capita GDP growth corrected for the catching-up term. While the upper figure clearly indicates that the largest contribution to per capita potential growth is the level of GDP per capita in most EU

[9] It is well known that Belgium conducted sound fiscal policies with high primary surpluses after joining the euro area. Possibly good institutions are conducive to disciplined fiscal policies.

non-EA countries, the contribution of the remaining explanatory variables is also important. In particular, the contribution of institutions and debt is generally more relevant for the euro-area countries than the rest of the EU.

3.2 Changing the country coverage and the debt threshold

Our benchmark model (1) is also estimated by using different country groups and different debt thresholds. In this section we only consider the OLS estimates in view of the similarity of results obtained with 2SLS (2SLS estimates are reported in Annex 3).

Changing the country coverage allows to test if the three types of initial conditions (GDP per capita, debt and institutions) used in model (1) change their significance for different country groups and different exchange rate regimes. Table 3 shows that when enlarging the group by other OECD countries (based on data availability), the sign and significance of the estimated coefficients remain unaltered. The table shows also the results for 2 sub-groups: the euro-area plus fixed exchange rate countries in the EU, and the countries (EU plus other OECD) with flexible exchange rates. While the significant drop of observations makes the results less robust, it seems that the model works better for the fixed exchange rate group than for the flexible exchange rate group. In particular, institutional delivery seems more important for the group of countries that have fixed exchange rates or are in the euro area than in the countries with flexible exchange rate regimes.

Table 3. Changing the country coverage (OLS estimates)

	EU (27)	**EU + other OECD (33)**	**Fixed ER (21)**	**Flexible ER (12)**
Log GDP (PPP)	-0.589***	-0.551***	-0.634***	-0.402***
	(0.0386)	(0.0468)	(0.0483)	(0.0735)
Institutional delivery	0.0951***	0.0904**	0.124**	0.00785
	(0.0317)	(0.0391)	(0.0465)	(0.0765)
(Debt>60)	-0.0394*	-0.0716**	-0.0507	-0.0895
	(0.0197)	(0.0297)	(0.0322)	(0.0517)
(Debt>60) x Institutional delivery	0.131***	0.114***	0.133***	0.0873
	(0.0283)	(0.0413)	(0.0425)	(0.069)
Constant	2.127***	2.032***	2.237***	1.657***
	(0.0988)	(0.118)	(0.121)	(0.186)
Observations	*208*	*246*	*160*	*86*
R-squared	*0.911*	*0.849*	*0.880*	*0.834*

Robust standard errors in parentheses

**** p<0.01, ** p<0.05, * p<0.1*

Other OECD: CA, IS, JP, NO, TR, US

Flexible ER: CZ, GB, HU, PL, RO, SE, CA, IS, JP, NO, TR, US

Fixed ER: (early EA and fixed exchange rate and late EA joining countries: CY, EE, LT, LV, MT, SI, SK, BG, DK, HR.

The results seem to indicate that in the fixed exchange rate group (with 21 countries) catching-up conditions are slightly better than in the larger and mixed groups (with 27 or 33 countries), provided that institutions are strong. In the fixed exchange rate group, the significance of the

debt dummy drops; however, the interaction term remains highly significant, indicating that the quality of institutions is particularly important in the presence of high debt.[10]

Changing the debt threshold allows to test whether the results depend on a specific debt level and if institutions matter differently for low versus high debt. Three cases are considered:

- A dummy that takes the value of 1 when Government Debt is above 50% of GDP. This value was chosen because a value around 50% of GDP was the un-weighted average of EU countries debt level in 1999 (the average EU27 debt level in the range 1995 to 2002 is 52% of GDP).
- A dummy that takes the value of 1 when Government Debt is above 70% of GDP. This value was chosen because a value close to 70% of GDP was the un-weighted average of Early EA countries' debt level in 1999 (the average Early-EA debt level in the range 1995 to 2002 is 71% of GDP).
- Government Debt-to-GDP ratio enters directly in the equation, while the interaction term is constructed with actual debt in deviation from the 60% of GDP threshold.

Table 4. Changing debt thresholds (OLS) – Baseline sample EU27

	15-year average potential GDP growth (in PPP)			
Debt threshold	T=60 Baseline	T=50	T=70	No threshold. Debt centred at 60% for the interaction term
Log GDP (PPP)	-0.589***	-0.567***	-0.600***	-0.556***
	(0.0386)	(0.0413)	(0.0396)	(0.0412)
Institutional delivery	0.0951***	0.0663*	0.122***	0.153***
	(0.0317)	(0.0348)	(0.0330)	(0.0299)
(Debt>T)	-0.0394*	-0.0670**	-0.0272	-0.000459
	(0.0197)	(0.0243)	(0.0249)	(0.000391)
(Debt>T) x Institutional delivery	0.131***	0.150***	0.120***	0.00291***
	(0.0283)	(0.0291)	(0.0348)	(0.000571)
Constant	2.127***	2.080***	2.154***	2.013***
	(0.0988)	(0.103)	(0.102)	(0.105)
Observations	*208*	*208*	*208*	*208*
R-squared	*0.911*	*0.926*	*0.900*	*0.917*

Robust standard errors in parentheses.

**** p<0.01, ** p<0.05, * p<0.1*

[10] Annex 4 reports the estimates for the EU15 and the CEECs (transformation countries in Table 1) separately, to take into account the differences between the two groups in terms of GDP per capita, initial level of debt and institutions. The same exercise is shown for the whole EU and EU15 excluding Greece, to test if Greece could be driving the results. Table A3a in Annex 4 shows the results are robust when considering the EU15 groups and when excluding Greece from the whole EU and EU15 group. For the CEECs alone, the variables on institutions drop their significance, suggesting that *within this group* institutional quality matters less at initial stages of catching-up, when the catching-up potential is still large, while initially other considerations (including the debt level) may be more important.

Table 4 shows that the estimated model is robust to a change in the debt threshold. The institutional delivery term coefficient increases its size with the inclusion of a higher debt dummy. The debt dummy loses significance, however, when the threshold is set at 70% of GDP, while it increases significance with the dummy is set at 50% of GDP. The loss of significance might be related to the fact that between 1995 and 2002 very few countries in the EU sample had debt levels above this threshold. Like in the previous specification this result seems to point to a relatively higher importance of institutional delivery for the expected long-term per capita growth in the case of highly indebted countries. There are several possible channels via which institutions may alleviate the debt problem. Good institutions may (i) allow for a better (potential growth enhancing) use of government expenditures financed by debt (e.g. the Scandinavian example); (ii) promote stronger growth via sound structural policies and/or, (iii) promote social fairness and allow for more efficient tax administration, thereby reducing the economic and social costs associated with high debt.

3.3 Some counterfactual exercises

To get the intuition behind the estimated models a few numerical counterfactual exercises could be useful. These exercises are carried out on the basis of the coefficient reported in Table 4 with the three debt-threshold dummies. We consider five countries in 1999: two high debt countries with below EU average institutional delivery (IT and GR), a low debt country with below EU average institutional delivery (SI) and two countries with initial debt between 50 and 60% with institutional delivery above the EU average (FR and PT), but well below the three best performers (FI, NL and DK).

In the first exercise (exercise 1 in Table 5) we assume that these five countries had been able by 1999 to achieve debt below the debt thresholds included in Table 4. According to the results reported in Table 4 debt below 50% would have been associated with substantial additional annual real GDP growth over the period 1999-2014. For example in case of initial debt below the threshold of 50% (60%) the associated additional annual real growth per annum would have been 0.8 (0.5) percentage points in Italy, 0.7 (0.5) p.p. in Greece, 0.3 p.p. in Portugal and 0.1 p.p. in France (as Slovenia had below 50% debt in 1999 this exercise is not relevant for this country).

Table 5. Counterfactual exercises

Exercise 1 - Average annual growth impact of reducing debt to below threshold (in %)

	IT			SI			FR			PT			GR		
Model	D50	D60	D70	D50	D60	D70	D50	D60	D70	D50	D60	D70	D50	D60	D70
Contribution debt	0.46	0.27	0.18	0	0	0	0.46	0.27	0	0.46	0	0	0.46	0.27	0.18
Contribution interaction term	0.27	0.24	0.22	0	0	0	-0.3	-0.3	0	-0.1	0	0	0.24	0.21	0.19
Total	**0.75**	**0.51**	**0.41**	**0**	**0**	**0**	**0.14**	**0**	**0**	**0.32**	**0**	**0**	**0.72**	**0.49**	**0.38**

Exercise 2 - Average annual growth impact of reducing debt to below threshold and moving institutions to EU Top 3 (in %)

	IT	SI	FR	PT	GR
Contribution institutional delivery	0.87	0.73	0.47	0.59	0.85
Contribution debt	0.27	0	0.27	0	0.27
Contribution interaction term	0.24	0	-0.3	0	0.21
Total	**1.45**	**0.73**	**0.47**	**0.59**	**1.4**

In the second counterfactual exercise, we assume a starting level of debt below the Maastricht threshold of 60% and in addition a converge to the three best institutional delivery performers in the EU (e.g. FI, NL and DK).[11] This starting position would have been associated according to the models in table 4 with additional 15 year average annual per capita growth of 1.5 percentage points per year in Italy, 1.4 pp in Greece, 0.7 pp. in Slovenia, 0.6 pp in Portugal and 0.5 pp in France (Table 5).[12]

4. Expanding the original model

The empirical growth literature usually contains a much larger set of macroeconomic variables included among the regressors. These variables do not usually cover the institutional set-up as captured by the institutional delivery indicators but other structural characteristics of the economy, such us the level of education, the saving rate, trade openness, the share of government expenditure on top of the initial level of GDP per capita (Barro, 1998; 1991; Barro & Sala-i-Martin, 1995; Easterly & Rebelo, 1993). To check whether model (1) could potentially

[11] Note that for PT and SI this counterfactual result is only associated with improved institutions, as the initial debt level in 1999 was below 60%, while for the other three countries the results reflect both lower debt levels and improved institutions at the start of 1999, compared to the actual values.

[12] Comparing the first and the second exercise suggests that e.g. in the case of Greece 0.5pp higher annual real growth is associated with the lower initial debt level, and an additional 0.9pp annual growth is associated with a much improved institutional quality, given debt below 60%. Given that the importance of above average institutions increases with the debt threshold, debt above the higher threshold (70%) coupled with very good institutions can be associated with even higher real growth. To remain on the prudent side, we do not think that this effect should be included in the counterfactual exercises, also as it seems driven by relatively few observations. In any case, the counterfactual result of the impact of better institutions on long-term growth appears rather large also without this effect.

suffer from an omitted variable problem, this section looks at the outcome of an augmented model:

$$(4) \qquad \Delta y_{c,t} = \alpha + \beta_y\, y_{c,t} + \beta_D D_{c,t} + \beta_I I_{c,t} + \beta_{DI} D_{c,t} I_{c,t} + \beta_z Z_{c,t} + \varepsilon_c$$

where $Z_{c,t}$ is a matrix which includes the following variables: trade openness (Imports + Exports in percent GDP); government expenditures (which has been adjusted for bank recapitalisation in percent of GDP); households savings rate; participation rate (labour force in % of working age population); level of education (percentage of the working age population with medium upper secondary education attainment or higher). These variables are typically included in regression analyses, which try to explain long-term growth differences across countries.

Table 6 reports the estimation results of the expanded model (4). It shows the results of six variants of the benchmark model, by using an incremental approach. Table 6 shows that the institutional delivery and the interaction term remain highly significant throughout variants (1) to (6). By contrast the debt threshold dummy loses significance in four out of the six variants. Among the additional variables, Table 6 shows that, while the sign of the additional variables is correct, only the level of education seems to have some limited significance in variant (6), while all other variables are found to be insignificant and are also not able to alter the validity of the original model.

Overall these exercises show that the parsimonious model seems relatively robust to the inclusions of additional macroeconomic/structural variables. The fact that the latter variables are not found to be significant might have different explanations: first, this model aims at explaining growth performances across similarly developed economies while the additional variables typically explain growth differences across developed and developing countries; second, some of the additional variables might present some degree of collinearity with the institutional delivery, particularly in the case of education, which is not significant in variant (5) but only in variant (6); and third, the time-span (i.e. 8 years running from 1995 to 2002) implies that there is a relatively limited time-series variability, which might also reduce the significance of the additional explanatory variables.

Table 6. Expanding the original model for the EU27 countries

	15-year average potential GDP growth (in PPP)						
	Baseline	(1)	(2)	(3)	(4)	(5)	(6)
Catching Up	-0.589***	-0.588***	-0.588***	-0.559***	-0.586***	-0.551***	-0.550***
	(0.0386)	(0.0395)	(0.0386)	(0.0453)	(0.0365)	(0.0397)	(0.0537)
Institutional delivery	0.0951***	0.0969***	0.102***	0.0736**	0.0885***	0.0763**	0.0718**
	(0.0317)	(0.0317)	(0.0354)	(0.0308)	(0.0301)	(0.0297)	(0.0341)
(Debt>60)	-0.0394*	-0.0346*	-0.0319	-0.0486**	-0.0301	-0.0383	-0.00518
	(0.0197)	(0.0182)	(0.0212)	(0.0215)	(0.023)	(0.0271)	(0.0233)
(Debt>60) x Institutional delivery	0.131***	0.123***	0.138***	0.134***	0.124***	0.128***	0.0799***
	(0.0283)	(0.0266)	(0.0285)	(0.0248)	(0.0286)	(0.0364)	(0.0266)

Trade openness		0.035					0.0355
		(0.0385)					(0.035)
Government expenditure			-0.0985				-0.102
			(0.124)				(0.116)
Savings rate				-0.00161			0.00227
				(0.00176)			(0.00264)
Participation rate					0.00193		0.00374
					(0.00235)		(0.00274)
Education						0.00114	0.00157*
						(0.00079)	(0.00077)
Constant	2.127***	1.969***	2.039***	2.069***	1.980***	2.030***	1.491***
	(0.0988)	(0.214)	(0.157)	(0.106)	(0.189)	(0.102)	(0.29)
Observations	*208*	*208*	*208*	*195*	*208*	*173*	*166*
R-squared	*0.911*	*0.914*	*0.914*	*0.925*	*0.912*	*0.897*	*0.922*

Robust standard errors in parentheses

**** p<0.01, ** p<0.05, * p<0.1*

5. Expanding the sample period and testing for different proxy of institutional quality

The relatively limited time variation, from 1995 to 2002, and the fact that the institutional delivery indicator moves very slowly through time might lead to the conclusion that the time dimension of the results is relatively weak. Given the data limitation on the institutional delivery indicator (only available from 1995 onwards), to test whether the quality of institutions remains an important explanatory variable through time, we use a series of proxies for this variable. In particular, three measures of institutional quality have been available since 1975: economic complexity, the Chin-Ito openness and the Fraser Institute Economic Freedom.

Results are reported in Table 7. The first column shows the benchmark model. Model (1) replaces our institutional delivery indicator by the Economic Complexity index (ECI), model (2) by the Chinn-Ito Financial Openness Index (KAOPEN), model (3) by the Fraser Institute Economic Freedom (EFF), and model (4) by the Heritage Foundation Economic Freedom (EFH). All these indicators are standardised such that higher values represent better institutions and they are centred on the cross-country linear average in 1998.

The ECI is a holistic measure of the production characteristics of countries, which embeds the knowledge accumulated and the country's industrial composition. This information is used to create measures of the relative complexity of a country's exports (Hidalgo & Ricardo, 2009). KAOPEN is a measure of a country's degree of capital account openness (Chinn & Ito, 2006), based on restrictions to cross-border financial transactions. The EFF measures the degree to which the policies and institutions of countries are supportive of economic freedom (Block, 1991). This latter concept is assessed against personal choices, voluntary exchanges, freedom

to enter markets and compete, and security of the person and privately owned property. The summary index measures the degree of economic freedom in the five broad areas: size of government, legal structure and property rights, access to sound money, international trade and regulation of credit, labour and business. The EFH is based on 10 quantitative and qualitative factors measuring: rule of law, limited government, regulatory efficiency and open markets (Miller & Kim, 2016). The first two indicators (ECI and KAOPEN) are not directly measuring the quality of institutions but only indirectly (and in a more narrow sense) via the observed complexity of the economic system or via the extent to which a country is subject to financial transaction costs. But the other two indicators are a closer proxy of the institutional delivery as they attempt to measure the efficiency of economic institutions. The last indicator in Table 7 is available only since 1995, i.e. it covers the same time span as the institutional delivery.

Table 7. Expanding the sample period for the EU 27 countries

	15-year average potential GDP growth (in PPP)				
Institutions	Baseline	ECI (1)	KAOPEN (2)	EFF (3)	EFH (4)
Catching Up	-0.589***	-0.522***	-0.538***	-0.596***	-0.519***
	(0.0386)	(0.0179)	(0.0161)	(0.0255)	(0.0264)
Institutions	0.0951***	0.0676**	0.0371***	0.0757***	0.00445*
	(0.0317)	(0.0321)	(0.0102)	(0.0218)	(0.00238)
(Debt>60)	-0.0394*	0.0230	0.0303	0.0226	0.00215
	(0.0197)	(0.0326)	(0.0312)	(0.0239)	(0.0248)
(Debt>60) x Institutions	0.131***	0.0535	-0.00929	0.0522**	0.0108***
	(0.0283)	(0.0389)	(0.0191)	(0.0206)	(0.00277)
Constant	2.127***	1.941***	2.000***	2.139***	1.941***
	(0.0988)	(0.0448)	(0.0467)	(0.0664)	(0.0694)
Observations	208	454	458	470	200
First observation	1995	1975	1975	1975	1995
R-squared	0.911	0.873	0.865	0.882	0.883

Robust standard errors in parentheses

**** p<0.01, ** p<0.05, * p<0.1*

Table 7 shows that when extending the sample period by 20 years, i.e. advancing the starting date from 1995 to 1975 (models (1) to (3)) the role of institutions remains equally important to explain long-term per capita growth. When comparing all specifications (i.e. also including model (4)) the significance of the institutional variable is maintained. In models (1) to (3) one can also observe that the significance of the debt threshold dummy and the interaction term is notably reduced. Only in model (3) does the interaction term continue to be significant. Thus, from a longer-term perspective, it seems that the quality of institutions matters more than the level of indebtedness and that the 60% threshold dummy itself does not play a role in explaining per capita long-term growth since the 1970s. However, in the cases of the EFF and EFH indicators, which are closer proxies of institutional delivery than the ECI and CAOPEN, the interaction term between debt and institutions remains significant, again supporting the

view that high quality of institutions is important in the presence of high debt. Given the longer time series used in model (1) to (3), it is interesting to test how an augmented version of the models would work. Tables A9 (1-4) in Annex 5 report the results of the augmented versions of models (1-4) in Table 7. The inclusion of additional variables follows the same principle used in Table (6). Tables A9 (1-4) show that coefficient on institutions continue to be very significant, moreover the interaction term between debt and institutions remains significant together with three additional explanatory variables: trade openness, participation rate and education in most of the specifications.

Overall, the extension of the sample period continues to support the importance of institutions for supporting higher long-term per capita growth. However, the evidence on the importance of debt becomes weaker and the model's specification seems to miss some explanatory variables when we go back to the 1970s.

6. Additional robustness exercises

In this section we report three additional robustness exercises to test the validity of our benchmark model. First we use a variant of the model where the focus is on the interaction between the debt dummy threshold and institutional delivery form the countries which have below average institutional delivery; second we test the robustness of the results by changing the measures of long-term per capita GDP growth and finally we change the time span of the target variable, per capita GDP growth, from annual to twenty-year average growth to see of the information content of the model changes for short, medium and long term growth.

6.1 Truncated institutions in the interaction term

To stress the importance of the link between high debt and good institutions, Table 8 reports the results where the institutional delivery variable is truncated for values above the EU average and only this truncated term (which only includes below EU average quality of institutions) is then multiplied by the debt threshold dummy. Table 8 shows that the introduction of a truncated variable leads to a drop in the significance of the debt dummy, irrespective of the value of the threshold and even when debt enters directly in the equation. However the interaction term remains highly significant and its coefficient becomes larger, suggesting that improving the quality of institutions, and reducing the level of debt, is particularly important for countries with below average institutional delivery in the presence of high debt. In all specifications better institutions are associated with higher long-term per capita growth and this positive link becomes stronger for the countries with high debt.

Table 8. Truncated institutions in the interaction term (OLS) – Baseline sample EU27

	15 year average potential GDP growth (in PPP)			
Debt threshold	T=60	T=50	T=70	No threshold. Debt centred at 60% for the interaction term
Log GDP (PPP)	-0.624***	-0.608***	-0.620***	-0.570***
	(0.0407)	(0.0421)	(0.0405)	(0.0385)
Institutional delivery	0.136***	0.135***	0.141***	0.156***
	(0.0331)	(0.0361)	(0.0330)	(0.0305)
(Debt>T)	0.0165	-0.0228	0.0140	0.000225

	(0.0194)	(0.0334)	(0.0283)	(0.000431)
(Debt>T) x Negative Institutions	0.163***	0.128**	0.157**	0.00361***
	(0.0512)	(0.0563)	(0.0636)	(0.000870)
Constant	2.216***	2.190***	2.205***	2.050***
	(0.107)	(0.107)	(0.106)	(0.0997)
Observations	208	208	208	208
R-squared	0.900	0.903	0.896	0.913

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

6.2 Different measures of per capita GDP growth and GDP levels

Another robustness check consists of assessing the sensitivity of the model (1) to changing the measure of per capita long-term GDP growth. Throughout the paper the baseline measure of per capita long term GDP growth has been the European Commission (EC) estimates of the PPP-adjusted potential GDP per capita. The choice was dictated by the need to consider a trend variable and to correct it for the purchasing power (PPP-adjustment) of the different EU countries. However, given the unobservable status of potential output estimates and the uncertainty related to PPP-adjustment estimates some robustness checks on these two parameters are warranted.

The robustness check is carried out by using four alternative measures of long-term per capita GDP growth (Table 9):

Actual real GDP PPP-adjusted: in this case the EC PPP-adjusted potential GDP per capita estimates are replaced by actual PPP-adjusted GDP per capita figures (Table 9 (1)).

Actual real GDP: in this case the **EC** PPP-adjusted potential GDP per capita estimates are replaced by real GDP per capita estimates (Table 9 (2)).

IMF Potential GDP: in this case the **EC** PPP-adjusted potential GDP per capita estimates are replaced by IMF potential GDP per capita estimates. It should be noted that the IMF doesn't provide the full history for the countries that more recently joined the EU and euro area (Table 9 (3)).

Potential GDP relative to the EU average: in this case instead of taking the **EC PPP-adjusted** potential GDP per capita estimates we use for the target variable and for the explanatory variable the PPP adjusted GDP per capita relative to the European Union average (Table 9 (4)).

The results in Table 9 show that the regression model (1) is robust to measurement changes of the 15-year average GDP growth. Generally, the catching-up coefficient becomes smaller when using other measures of per capita GDP growth while the institutional delivery coefficient becomes larger. The significance of the debt threshold dummy is somewhat reduced, but the significance of the interaction term remains intact. From these exercises one can conclude that the measurement uncertainty related to "potential" and "PPP-adjustment" does not distort the results.

Table 9. Different measures of GDP growth and GDP levels

	15 year average per capita GDP growth				
	Baseline	Actual PPP Log (1)	Actual Real Log (2)	IMF Pot Real Log (3)	EC Pot PPP RelEU (4)
PPP Log	-0.589***	-0.597***			
	(0.0386)	(0.0441)			
Real Log			-0.403***	-0.373***	
			(0.0499)	(0.0398)	
PPP RelEU					-0.469***
					(0.0509)
Institutions	0.0951***	0.0909**	0.146**	0.148***	6.432**
	(0.0317)	(0.0359)	(0.0533)	(0.0455)	(2.455)
(Debt>60)	-0.0394*	-0.0540*	-0.0401	-0.0401	-3.208
	(0.0197)	(0.0271)	(0.0298)	(0.0269)	(2.002)
(Debt>60) x Institutions	0.131***	0.150***	0.161***	0.144***	11.63***
	(0.0283)	(0.0384)	(0.0400)	(0.0327)	(3.237)
Constant	2.127***	2.134***	1.374***	1.296***	46.05***
	(0.0988)	(0.113)	(0.131)	(0.101)	(4.024)
Observations	208	208	208	184	208
R-squared	0.911	0.896	0.799	0.766	0.776

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

6.3 Varying time spans and starting levels

The final robustness check consists of evaluating to what extent the regression results depend on the starting level and on the time span used. This exercise is needed to test if the robustness of the results depends on the chosen sample period, both in term of starting level used for the regressors and in term of time span used for GDP growth variable. The robustness check is done by estimating 380 cross-sectional equations (19 base years and 20 years of possible time spans) for equation (1) above. In other words, starting at the base year 1996, twenty cross-sectional regressions have been carried out on that base year to explain an average GDP growth that goes from one to 20 years. The results are shown in form of a matrix where the y axis represents the time span and the x axis the starting or base year.

Equation (5) modifies model (1) by changing the base year and the time span:

$$(5) \qquad \left(y_{c,t=Base+Span} - y_{c,t=Base}\right) =$$

$$\alpha + \beta_y\, y_{c,t=Base} + \beta_D (D>60)_{c,t=Base} + \beta_I I_{c,t=Base} + \beta_{DI} (D>60)_{c,t=Base} I_{c,t=Base} + \varepsilon_c$$

Tables 10 report the values of the R^2 in equation (5). It is possible to observe that the explanatory power of the regression is larger the longer is the time span considered for the

average per capita GDP growth. In particular the R^2 is relatively higher for average GDP growth rates which include more than 9 years of observations. The matrices with t-statistics of the explanatory variables are reported in Annex 6. They show that the significance of the model is maintained for different base years and time span, but the performance is better for longer time-span. Overall this exercise suggests that the model is more suitable to explain long-term growth performances and not the business-cycle frequencies. It also suggests that the model would continue to perform well even when taking a longer time span than the one used in the paper.

Table 10. R^2 of equation (5)

Span \ Base	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Span
1	30	26	43	15	56	49	56	52	62	61	77	58	45	31	41	47	24	31	48	1
2	26	32	28	39	57	64	64	70	68	76	75	73	49	43	56	45	31	46	49	2
3	39	33	38	49	68	68	74	73	77	76	81	69	52	51	52	47	42	50	50	3
4	39	43	50	62	72	75	76	78	79	82	77	69	57	53	51	52	46	52		4
5	46	55	62	70	79	77	81	81	85	80	77	71	57	54	55	54	48			5
6	57	63	69	77	81	82	83	86	83	80	78	71	58	58	56	55				6
7	64	68	76	79	85	85	88	85	83	82	78	71	59	60	57					7
8	69	74	78	83	88	90	88	85	84	82	78	70	60	61						8
9	73	78	82	87	92	90	87	85	84	82	77	69	60							9
10	77	83	87	92	93	89	88	86	85	82	76	68								10
11	82	88	92	92	92	90	88	86	84	81	75									11
12	88	92	92	92	92	90	88	86	84	80										12
13	92	93	92	92	93	90	87	85	83											13
14	93	93	92	92	92	89	87	84												14
15	94	94	93	92	92	88	86													15
16	94	94	92	91	91	87														16
17	94	93	91	90	90															17
18	94	93	90	90																18
19	93	92	90																	19
20	93	91																		20
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	

Given the above results a few variants of the target variable are considered in Table 11. We test how the model performs for three measures of the long-term per capita GDP growth. First, we reduce the overlapping period and assume that we have only three different data points for the 15-year average GDP per capita growth (1996, 1999 and 2002); second we consider only the 20-year average per capita GDP growth and third we consider two non-overlapping 10-year average per capita GDP growth. These variants imply a significant drop of the available observations and basically the model is reduced to a cross-sectional analysis. This notwithstanding institutional delivery and its interaction with the debt threshold dummy remain largely significant.[13]

[13] Only in the 20-year version starting in 1996, which suffers from a substantial drop of observations, institutions alone are no longer significant. However, in this case the interaction term is significantly stronger than in the baseline and the other variants.

Table 11. Varying growth spans

	average potential per capita GDP growth (in PPP)			
Outcome	Baseline	15yr starting 1996/1999/2002	20yr starting 1996	10yr non-overlapping
Catching Up	-0.589***	-0.572***	-0.685***	-0.471***
	(0.0386)	(0.0430)	(0.0602)	(0.0378)
Institutions	0.0951***	0.0892**	0.0654	0.127***
	(0.0317)	(0.0359)	(0.0435)	(0.0304)
(Debt>60)	-0.0394*	-0.0549**	-0.0424	-0.00512
	(0.0197)	(0.0239)	(0.0408)	(0.0226)
(Debt>60) x Institutions	0.131***	0.151***	0.244***	0.0809*
	(0.0283)	(0.0354)	(0.0530)	(0.0430)
Constant	2.127***	2.080***	2.469***	1.674***
	(0.0988)	(0.108)	(0.146)	(0.101)
Observations	*208*	*78*	*25*	*52*
R-squared	*0.911*	*0.904*	*0.926*	*0.843*

Robust standard errors in parentheses

**** p<0.01, ** p<0.05, * p<0.1*

7. Conclusions

This paper tried to explain the different long-term per capita GDP growth performances in Europe by using a parsimonious empirical model, testing if and how the initial quality of institutions and government debt are important determinant of long term growth in Europe. The benchmark model explains long-term growth by the initial levels of government debt, quality of institutions (institutional delivery) and an interaction term between the two variables, on top of the initial level of GDP per capita (to account for the catching-up potential). The sample period used for the initial level of variables runs from 1995 to 2002, while long term per capita growth is the 15-year average potential per capita GDP growth estimated by the Commission.

The benchmark model is estimated for the whole Europe, the OECD and for two groups of countries: countries with fixed exchange rate regimes and belonging to a monetary union, and countries with flexible exchange rate regimes. The findings of the paper support the view that the quality of institutions is an important determinant of long-term growth. The results seem particularly important for countries where institutional delivery is below or around the EU average and initial public debt is above a threshold (e.g. 60 or 70%). Such countries could experience significantly higher per capita GDP growth if their institutions were improved. Interestingly, initial debt levels above 60% or 70% appear not negative for long-term growth in the presence of very sound institutions. While this result needs to be treated carefully as it is driven by rather few observations, it might suggest that debt thresholds above which debt levels are detrimental for growth are not the same across countries, but could to be endogenous to the quality of public institutions.

While the results hold across different group of countries, it appears that the conditions for real convergence are generally also good for the group of euro area and fixed exchange rate

countries. At the same time the quality of institutions might be particularly important for this group. This could reflect that sound institutions – and the associated policies - are helpful to compensate for the lack of exchange rate tool as adjustment and disciplinary device, supporting the view that improvements in institutions and structural reforms are particularly important for euro area countries to reap the full benefits of monetary union. However, this result is preliminary and requires further research.

The benchmark model is changed in several ways to check the validity of the results. First the results are assessed against different debt thresholds (corresponding to the EU average, the Maastricht threshold and the EA average); second the model is augmented with different control variables which are typically included in the growth literature (education attainment, saving rate, government expenditure, etc.); third other measures of institutional quality are used as a proxy for institutional delivery, which allow for extending the sample period considered by 20 years, i.e. advancing the starting date from 1995 to 1975. These changes continue to support the evidence that institutional delivery is a critical determinant of long-term growth in Europe; however the significance of debt thresholds turns out to be less robust to the above changes.

A variant of the benchmark model is also shown to further avail the results that moving towards good institutions is particularly important when debt is high. To stress this link, the institutional delivery variable is truncated for values above the EU average and only this truncated term (which only includes low quality institutions) is then multiplied by the debt threshold dummy.

Finally other robustness exercises are reported by using different measures of long-term growth and different time-spans. Also these exercises show that the estimates obtained with the benchmark model are relatively robust to changes in specifications.

There are of course many factors which are not or only partially included in the institutional variables used here, which can enhance longer-term growth. For example macroeconomic stability, sound fiscal policies, efficient education systems and incentives for investment in human and real capital, a high degree of flexibility and openness in product and labour markets, well capitalised and supervised financial institutions, efficient insolvency frameworks, conditions for an efficient use of capital and labour, including via higher economic integration within the EU and a more active use of national policy tools to prevent asset price and credit boom-bust cycles. The results of this paper are broadly consistent with the view that the World Bank (or other) indicators measuring the quality of institutions cover key factors and mechanisms, which also determine the probability that governments and societies in the future support policies and reforms in the above areas, enhancing long-term growth. The link between institutional quality and the probability of the above mentioned sound policies and reforms which enhance long-term growth has however not been tested explicitly. It is left for further research.

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Annex 1. Analysis of the evolution of the institutional delivery indicators

This annex looks at the evolution of the institutional delivery indicators over time. The analysis is done by using the difference in difference approach, where the 28 EU countries have been divided in five groups defined as follows:

- Early EA-high: the early euro area joiners with the WGI in 1996 > 1.33
- Early EA-low: the early euro area joiners with the WGI in 1996 < 1.33
- New EA: the countries that joined the EA since 2001
- NOEA- high: the countries not part of the EA with WGI in 1996 > 1.33
- NOEA- low: the countries not part of the EA with WGI in 1996 < 1.33

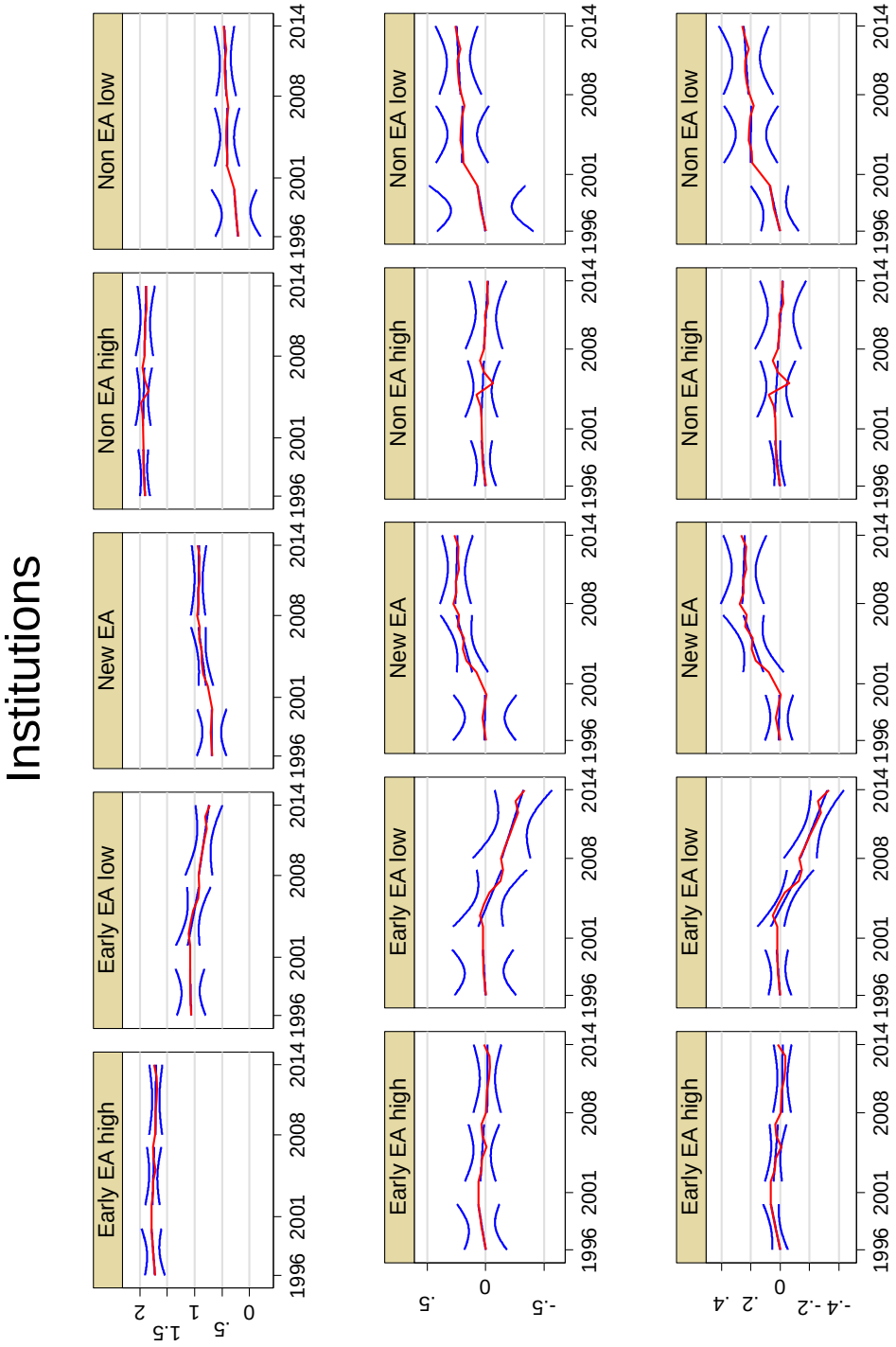
The breakpoint of 1.33 was decided upon using a difference in difference calculation, where this cut off reached the highest R^2.

Table A1. Evolution of institutional delivery indicators, 1996, 2008 and 2014

		WGI delivery (not transformed)			
		1996	*>1.33*	**2008**	**2014**
GR	Early EA	0.70		0.60	0.22
IT	Early EA	0.75		0.48	0.32
FR	Early EA	1.26		1.43	1.31
PT	Early EA	1.30		1.04	0.95
ES	Early EA	1.30		1.11	0.85
BE	Early EA	1.41	*x*	1.36	1.41
IE	Early EA	1.64	*x*	1.72	1.69
DE	Early EA	1.70	*x*	1.62	1.78
AT	Early EA	1.79	*x*	1.81	1.61
LU	*Early EA*	*1.87*	*x*	*1.77*	*1.82*
FI	Early EA	1.89	*x*	1.99	2.06
NL	Early EA	1.92	*x*	1.84	1.90
LV	New EA	0.10		0.63	0.84
SK	New EA	0.40		0.72	0.59
LT	New EA	0.45		0.61	0.89
EE	New EA	0.59		1.15	1.34
MT	New EA	0.88		1.28	1.05
SI	New EA	1.07		0.98	0.83
CY	New EA	1.28		1.33	1.09
BG	non EA	-0.41		0.05	0.08
HR	non EA	-0.38		0.27	0.40
RO	non EA	-0.17		0.02	0.15
PL	non EA	0.66		0.54	0.82
CZ	non EA	0.78		0.83	0.87
HU	non EA	0.78		0.80	0.48
SE	non EA	1.84	*x*	1.93	1.93
GB	non EA	1.90	*x*	1.68	1.77
DK	non EA	1.96	*x*	2.14	1.97

The figures below show the country group mean development of WGI-delivery over time (red line) and the linear fits split into three intervals: 1996-2001, 2002-2008 and 2009-2014. The first row shows absolute values, the second row allows for group fixed effects in 1996 and the last row allows for country fixed effects in 1996.

Figure A1. Country group mean development of WGI-delivery, 1996-2014



Annex 2. General government debt

The table below shows the general government debt in percent of GDP. Countries are ordered by debt level in 1999. Values larger than 60% formatted in bold.

Table A2. General government debt, 1996-2014 (% of GDP)

	1996	1997	1998	1999	2000	2001	2008	2014
BE	**128.0**	**123.2**	**118.2**	**114.4**	**108.8**	**107.6**	**92.4**	**106.7**
IT	**116.3**	**113.7**	**110.8**	**109.6**	**105.1**	**104.7**	**102.3**	**132.3**
GR	**101.2**	**99.3**	**97.2**	**98.6**	**104.7**	**106.8**	**109.4**	**178.6**
BG		**97.3**	**69.3**	**76.1**	**71.2**	**64.7**	13.0	27.0
AT	**68.0**	**63.2**	**63.6**	**66.4**	**65.9**	**66.5**	**68.5**	**84.2**
MT	38.7	46.6	51.2	**62.1**	**60.9**	**65.5**	**62.7**	**66.9**
SE	**70.3**	**68.2**	**66.7**	**61.5**	50.6	51.7	36.8	44.9
ES	**65.6**	**64.4**	**62.5**	**60.9**	58.0	54.2	39.4	**99.3**
FR	59.7	**61.1**	**61.0**	**60.2**	58.7	58.2	**68.1**	**95.6**
DE	57.6	58.8	59.4	**60.0**	58.9	57.7	**65.0**	**74.9**
HU	**71.6**	**62.1**	**60.0**	59.9	55.1	51.7	**71.6**	**76.2**
NL	**71.2**	**65.6**	**62.5**	58.2	51.4	48.7	54.5	**68.2**
DK	**69.9**	**65.8**	**61.8**	58.2	52.4	48.5	33.4	44.6
CY	49.2	53.2	54.8	55.1	55.1	56.9	45.1	**108.2**
PT	59.5	55.2	51.8	51.0	50.3	53.4	**71.7**	**130.2**
SK	30.5	33.0	33.9	47.1	49.6	48.3	28.2	53.5
IE	**69.9**	**61.6**	51.5	46.7	36.1	33.2	42.4	**107.5**
FI	55.3	52.2	46.9	44.1	42.5	41.0	32.7	59.3
GB	47.8	46.6	44.0	41.7	38.9	36.0	51.7	**88.2**
PL	42.4	42.3	38.4	39.0	36.5	37.3	46.6	50.4
SI	21.6	22.1	22.8	23.7	25.9	26.1	21.6	**80.8**
LT	13.9	15.4	16.5	22.7	23.5	22.9	14.6	40.7
RO	10.6	14.9	16.7	21.6	22.4	25.7	13.2	39.8
CZ	11.6	12.1	13.9	15.2	17.0	22.8	28.7	42.7
LV	13.3	10.7	9.0	12.1	12.1	13.9	18.7	40.8
EE	7.5	7.0	6.0	6.5	5.1	4.8	4.5	10.4
LU	7.6	7.5	7.2	6.4	7.6	6.6	14.4	23.0
HR						36.1	38.9	**85.1**
EA19	**72.7**	**72.2**	**71.7**	**70.6**	**68.0**	**67.0**	**68.5**	**94.5**
EU28						59.8	**61.0**	**88.6**

Annex 3. 2SLS estimates

This instrumental variable approach requires that the instruments (legal origin) are relevant i.e. they are correlated with the explanatory variable (institutions) and exogenous i.e. they are not correlated with the error term in our regression of interest. In our baseline regression institutions appear both independently and interacted with the debt>60 dummy. It can be argued that if legal origin is a valid instrument for institutions, then legal origins interacted with the exogenous debt dummy is also a valid instrument for institutions interacted with the debt dummy. The relevance of the instruments used can be tested by checking if the F-statistic of the first stage is larger than 10. As shown in Table A3 below, this criterion is met with ease if we don't require clustered standard errors however missed for the more robust version, with clustered standard errors.

Table A3. First stage of the 2SLS Regression results shown in Table 2

Explanatory variables	Institutions	(Debt>60) x Institutions	Institutions	(Debt>60) x Institutions
(Origin=English)	Omitted	Omitted	Omitted	Omitted
(Debt>60) x (Origin=English)	Omitted	Omitted	Omitted	Omitted
(Origin=French)	-0.127	0.0200	-0.127	0.0200
	(0.0809)	(0.0626)	(0.165)	(0.0248)
(Origin=Soviet)	-0.414***	0.115*	-0.414**	0.115
	(0.0895)	(0.0693)	(0.190)	(0.0781)
(Origin=German)	0.0689	-0.00983	0.0689	-0.00983
	(0.115)	(0.0893)	(0.143)	(0.0153)
(Origin=Scandinavian)	0.332***	-0.0151	0.332*	-0.0151
	(0.0900)	(0.0697)	(0.163)	(0.0199)
(Debt>60)	0.0384	0.521***	0.0384	0.521***
	(0.144)	(0.112)	(0.194)	(0.157)
(Debt>60) x (Origin=French)	-0.289*	-0.392***	-0.289	-0.392*
	(0.160)	(0.124)	(0.238)	(0.224)
(Debt>60) x (Origin=Soviet)	-0.0295	-1.214***	-0.0295	-1.214***
	(0.171)	(0.133)	(0.296)	(0.360)
(Debt>60) x (Origin=German)	-0.00134	0.253*	-0.00134	0.253
	(0.196)	(0.152)	(0.194)	(0.158)
(Debt>60) x (Origin=Scandinavian)	-0.0884	0.374***	-0.0884	0.374**
	(0.181)	(0.141)	(0.212)	(0.165)
Catching Up	0.782***	0.133**	0.782***	0.133
	(0.0694)	(0.0537)	(0.155)	(0.0867)
Constant	-1.782***	-0.401**	-1.782***	-0.401
	(0.216)	(0.168)	(0.487)	(0.261)

Observations	208	208	208	208
R-squared	0.843	0.691	0.843	0.691
Clustered standard errors	NO	NO	YES	YES
F-stat of excluded instruments	14.41	37.86	5.354	9.282

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

Table A4. Changing the country coverage (2SLS)

	EU	EU + other OECD	Fixed ER	Flexible ER
	(27)	(33)	(21)	(12)
Log GDP (PPP)	-0.611***	-0.624***	-0.567***	-0.568***
	(0.0413)	(0.0654)	(0.0560)	(0.0810)
Institutions	0.116***	0.159**	0.0626	0.163*
	(0.0394)	(0.0784)	(0.0508)	(0.0866)
(Debt>60)	-0.0357*	-0.0612**	-0.0611*	-0.0693*
	(0.0186)	(0.0252)	(0.0321)	(0.0383)
(Debt>60) x Institutions	0.123***	0.106**	0.131***	0.0371
	(0.0289)	(0.0499)	(0.0386)	(0.0706)
Constant	2.181***	2.219***	2.067***	2.087***
	(0.105)	(0.173)	(0.137)	(0.238)
Observations	*208*	*246*	*160*	*86*
R-squared	*0.910*	*0.842*	*0.874*	*0.803*

Robust standard errors in parentheses
**** p<0.01, ** p<0.05, * p<0.1*
Other OECD: CA, IS, JP, NO, TR, US
Flexible ER: CZ, GB, HU, PL, RO, SE, CA, IS, JP, NO, TR, US
Fixed ER: (early EA and fixed exchange rate and late EA joining countries: CY, EE, LT, LV, MT, SI, SK, BG, DK, HR

Table A5. Changing debt thresholds (2SLS) – Baseline sample EU27

15 year average potential GDP growth (in PPP)				
Debt threshold	T=60 Baseline	T=50	T=70	No threshold. Debt centred at 60% for the interaction term
Log GDP (PPP)	-0.611***	-0.590***	-0.633***	-0.556***
	(0.0413)	(0.0494)	(0.0422)	(0.0499)
Institutions	0.116***	0.0932*	0.151***	0.157***
	(0.0394)	(0.0503)	(0.0386)	(0.0366)
(Debt>T)	-0.0357*	-0.0641***	-0.0175	-0.000419
	(0.0186)	(0.0235)	(0.0252)	(0.000475)
(Debt>T) x Institutions	0.123***	0.133***	0.120***	0.00316***

	(0.0289)	(0.0363)	(0.0393)	(0.00111)
Constant	2.181***	2.140***	2.238***	2.012***
	(0.105)	(0.123)	(0.108)	(0.129)
Observations	*208*	*208*	*208*	*208*
R-squared	*0.910*	*0.925*	*0.899*	*0.917*

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

Table A6. Expanding the original model (2SLS) – Baseline sample EU27

	15 year average potential GDP growth (in PPP)						
Catching Up	-0.611***	-0.617***	-0.602***	-0.561***	-0.591***	-0.570***	-0.594***
	(0.0413)	(0.0434)	(0.0438)	(0.0568)	(0.0505)	(0.0544)	(0.0640)
Institutions	0.116***	0.123***	0.117**	0.0775*	0.0954*	0.0970**	0.116*
	(0.0394)	(0.0408)	(0.0531)	(0.0430)	(0.0540)	(0.0440)	(0.0636)
(Debt>60)	-0.0357*	-0.0315*	-0.0285	-0.0462**	-0.0277	-0.0265	-0.000569
	(0.0186)	(0.0182)	(0.0212)	(0.0198)	(0.0208)	(0.0239)	(0.0232)
(Debt>60) x Institutions	0.123***	0.122***	0.129***	0.120***	0.115***	0.0988***	0.0817***
	(0.0289)	(0.0298)	(0.0265)	(0.0245)	(0.0287)	(0.0331)	(0.0290)
Trade openness		0.0342					0.0304
		(0.0370)					(0.0330)
Government expenditure			-0.101				-0.135
			(0.135)				(0.140)
Savings rate				-0.00151			0.00216
				(0.00174)			(0.00242)
Participation rate					0.00198		0.00253
					(0.00291)		(0.00318)
Education						0.00127	0.00162**
						(0.000785)	(0.000710)
Constant	2.181***	2.046***	2.072***	2.071***	1.991***	2.077***	1.687***
	(0.105)	(0.182)	(0.115)	(0.132)	(0.311)	(0.141)	(0.228)
Observations	*208*	*208*	*208*	*195*	*208*	*173*	*166*
R-squared	*0.910*	*0.913*	*0.913*	*0.925*	*0.912*	*0.896*	*0.919*

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

Table A7. Expanding the sample period with different institutional indicators (2SLS)

15 year average potential GDP growth (in PPP)					
Institutions	WGI Baseline	Economic Complexity	Chinn-Ito Openness	Economic Freedom Fraser	Economic Freedom Heritage
Catching Up	-0.611***	-0.559***	-0.690***	-0.773***	-0.516***
	(0.0413)	(0.0306)	(0.0776)	(0.0870)	(0.0794)
Institutions	0.116***	0.134***	0.144***	0.202**	0.00375
	(0.0394)	(0.0464)	(0.0487)	(0.0848)	(0.00889)
(Debt>60)	-0.0357*	0.0235	0.0358	0.0189	0.000462
	(0.0186)	(0.0428)	(0.0292)	(0.0298)	(0.0459)
(Debt>60) x Institutions	0.123***	0.0875	-0.0569	0.115**	0.0122***
	(0.0289)	(0.0697)	(0.0682)	(0.0501)	(0.00308)
Constant	2.181***	2.019***	2.399***	2.582***	1.934***
	(0.105)	(0.0696)	(0.200)	(0.227)	(0.194)
Observations	*208*	*454*	*458*	*470*	*200*
First observation	*1995*	*1975*	*1975*	*1975*	*1995*
R-squared	*0.910*	*0.855*	*0.716*	*0.803*	*0.883*

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

Annex 4. Changing the country grouping

Table A8(a). Changing the country grouping

15-year average potential GDP growth (in PPP)					
VARIABLES	EU27 (baseline)	EU27 (excl. GR)	EU (15)	EU (15) (excl. GR)	CEECs (10)
Catching Up	-0.589***	-0.573***	-0.407***	-0.398***	-0.634***
	(0.0386)	(0.0350)	(0.0422)	(0.0426)	(0.0712)
Institutions	0.0951***	0.0833***	0.0671**	0.0629**	0.0722
	(0.0317)	(0.0288)	(0.0271)	(0.0262)	(0.0777)
(Debt>60)	-0.0394*	-0.0294*	-0.0519**	-0.0342	-0.120**
	(0.0197)	(0.0164)	(0.0228)	(0.0194)	(0.0436)
(Debt>60) x Institutions	0.131***	0.120***	0.142***	0.117***	0.0626
	(0.0283)	(0.0231)	(0.0359)	(0.0335)	(0.0504)
Constant	2.127***	2.085***	1.605***	1.579***	2.210***
	(0.0988)	(0.0897)	(0.124)	(0.126)	(0.192)
Observations	208	200	120	112	80
R-squared	0.911	0.914	0.659	0.675	0.862

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

Table A8(b). Changing the country grouping (2SLS)

15-year average potential GDP growth (in PPP)				
VARIABLES	EU27 (baseline)	EU27 (excl. GR)	EU (15)	EU (15) (excl. GR)
Catching Up	-0.611***	-0.596***	-0.415***	-0.413***
	(0.0413)	(0.0399)	(0.0513)	(0.0541)
Institutions	0.116***	0.104***	0.0787**	0.0787**
	(0.0394)	(0.0374)	(0.0394)	(0.0401)
(Debt>60)	-0.0357*	-0.0284	-0.0419*	-0.0172
	(0.0186)	(0.0173)	(0.0220)	(0.0218)
(Debt>60) x Institutions	0.123***	0.122***	0.122***	0.0868**
	(0.0289)	(0.0293)	(0.0362)	(0.0366)
Constant	2.181***	2.145***	1.621***	1.615***
	(0.105)	(0.100)	(0.148)	(0.156)
Observations	*208*	200	120	112
R-squared	*0.910*	0.913	0.657	0.672

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

Annex 5. Expanding the original model with additional variable and with different proxy of institutional quality

Table A9(1). Institutions refers to Economic Complexity

	15-year average potential GDP growth (in PPP)						
Catching Up	-0.522***	-0.539***	-0.484***	-0.484***	-0.507***	-0.468***	-0.488***
	(0.0179)	(0.0172)	(0.0281)	(0.0228)	(0.0310)	(0.0345)	(0.0304)
Institutions	0.0676**	0.0923***	0.0254	0.00484	0.0113	0.00737	0.0262
	(0.0321)	(0.0227)	(0.0373)	(0.0282)	(0.0308)	(0.0292)	(0.0323)
(Debt>60)	0.0230	0.0133	-0.00750	-0.0412	-0.0225	-0.0130	0.00696
	(0.0326)	(0.0283)	(0.0364)	(0.0241)	(0.0275)	(0.0196)	(0.0204)
(Debt>60) x Institutions	0.0535	0.0136	0.103***	0.129***	0.107**	0.0955***	0.0610**
	(0.0389)	(0.0432)	(0.0355)	(0.0284)	(0.0394)	(0.0246)	(0.0279)
Trade openness		0.123***					0.0658**
		(0.0334)					(0.0284)
Government expenditure			-0.135				-0.128
			(0.131)				(0.113)
Savings rate				-0.00126			0.00234
				(0.00179)			(0.00257)
Participation rate					0.00294*		0.00639***
					(0.00147)		(0.00198)
Education						0.00126	0.00124
						(0.000925)	(0.000847)
Constant	1.941***	1.469***	1.749***	1.882***	1.715***	1.821***	0.995***
	(0.0448)	(0.130)	(0.125)	(0.0556)	(0.0906)	(0.0927)	(0.194)
Observations	454	454	270	311	307	200	183
R-squared	0.873	0.901	0.866	0.900	0.896	0.840	0.925

Robust standard errors in parentheses

**** p<0.01, ** p<0.05, * p<0.1*

Table A9(2). Institutions refers to Chinn-Ito Index

	15-year average potential GDP growth (in PPP)						
Catching Up	-0.538***	-0.546***	-0.503***	-0.515***	-0.532***	-0.488***	-0.530***
	(0.0161)	(0.0175)	(0.0245)	(0.0248)	(0.0220)	(0.0262)	(0.0444)
Institutions	0.0371***	0.0353***	0.0254**	0.0241***	0.0154	0.0241**	0.0276***
	(0.0102)	(0.00996)	(0.00915)	(0.00861)	(0.00946)	(0.00959)	(0.00956)
(Debt>60)	0.0303	0.0205	-0.00282	-0.0181	0.00283	0.00279	-0.000956
	(0.0312)	(0.0254)	(0.0345)	(0.0246)	(0.0213)	(0.0244)	(0.0197)
(Debt>60) x Institutions	-0.00929	-0.00528	0.00941	0.0216	0.0293**	0.00408	0.0147
	(0.0191)	(0.0170)	(0.0148)	(0.0166)	(0.0129)	(0.0154)	(0.0145)
Trade openness		0.0680**					0.0639**
		(0.0322)					(0.0286)
Government expenditure			-0.0435				-0.0256
			(0.0879)				(0.0901)
Savings rate				0.000670			0.00402
				(0.00168)			(0.00296)
Participation rate					0.00313**		0.00663**
					(0.00145)		(0.00259)
Education						0.00161**	0.00175*
						(0.000698)	(0.000903)
Constant	2.000***	1.735***	1.869***	1.935***	1.764***	1.864***	1.155***
	(0.0467)	(0.140)	(0.114)	(0.0565)	(0.0997)	(0.0715)	(0.229)
Observations	458	458	280	307	316	207	187
R-squared	0.865	0.875	0.842	0.885	0.889	0.826	0.920

Robust standard errors in parentheses

**** p<0.01, ** p<0.05, * p<0.1*

Table A9(3). Institutions refers to Economic Freedom from the Fraser institute

	15-year average potential GDP growth (in PPP)						
Catching Up	-0.596***	-0.589***	-0.576***	-0.565***	-0.573***	-0.549***	-0.560***
	(0.0255)	(0.0230)	(0.0273)	(0.0324)	(0.0241)	(0.0349)	(0.0623)
Institutions	0.0757***	0.0681***	0.0555***	0.0468***	0.0378*	0.0581**	0.0497*
	(0.0218)	(0.0176)	(0.0195)	(0.0162)	(0.0191)	(0.0268)	(0.0244)
(Debt>60)	0.0226	0.0172	-0.0188	-0.0189	-0.00253	-0.0307	-0.00529
	(0.0239)	(0.0218)	(0.0180)	(0.0186)	(0.0169)	(0.0182)	(0.0219)
(Debt>60) x Institutions	0.0522**	0.0465*	0.104***	0.0707**	0.0808***	0.104***	0.0475*
	(0.0206)	(0.0241)	(0.0178)	(0.0271)	(0.0234)	(0.0277)	(0.0273)
Trade openness		0.0410					0.0444
		(0.0317)					(0.0330)
Government expenditure			-0.0290				0.00126
			(0.0777)				(0.102)
Savings rate				0.00103			0.00392
				(0.00169)			(0.00281)
Participation rate					0.00306**		0.00652**
					(0.00146)		(0.00265)
Education						0.00128*	0.00154
						(0.000692)	(0.000968)
Constant	2.139***	1.951***	2.062***	2.057***	1.868***	2.017***	1.343***
	(0.0664)	(0.136)	(0.0898)	(0.0722)	(0.113)	(0.0941)	(0.285)
Observations	470	470	286	319	323	207	187
R-squared	0.882	0.886	0.881	0.903	0.904	0.867	0.916

Robust standard errors in parentheses

**** p<0.01, ** p<0.05, * p<0.1*

Table A9(4). Institutions refers to Economic Freedom from the Heritage foundation

	15-year average potential GDP growth (in PPP)						
Catching Up	-0.519***	-0.513***	-0.537***	-0.496***	-0.527***	-0.489***	-0.520***
	(0.0264)	(0.0276)	(0.0306)	(0.0296)	(0.0224)	(0.0250)	(0.0513)
Institutions	0.00445*	0.00401*	0.00542**	0.00276	0.00409	0.00410	0.00344
	(0.00238)	(0.00226)	(0.00212)	(0.00212)	(0.00247)	(0.00275)	(0.00229)
(Debt>60)	0.00215	0.00259	-0.00067	-0.0135	0.0220	0.00771	0.0219
	(0.0248)	(0.0234)	(0.0260)	(0.0281)	(0.0211)	(0.0230)	(0.0209)
(Debt>60) x Institutions	0.0108***	0.0104***	0.0102***	0.0102***	0.01000***	0.0106***	0.00303
	(0.00277)	(0.00245)	(0.00320)	(0.00290)	(0.00245)	(0.00376)	(0.00315)
Trade openness		0.0313					0.0493
		(0.0370)					(0.0376)
Government expenditure			0.0915				0.0353
			(0.131)				(0.137)
Savings rate				-0.00132			0.00322
				(0.00215)			(0.00295)
Participation rate					0.00469**		0.00719***
					(0.00201)		(0.00249)
Education						0.00171***	0.00145
						(0.000603)	(0.000910)
Constant	1.941***	1.786***	2.062***	1.900***	1.625***	1.860***	1.205***
	(0.0694)	(0.185)	(0.167)	(0.0706)	(0.160)	(0.0698)	(0.286)
Observations	200	200	200	187	200	170	163
R-squared	0.883	0.886	0.885	0.896	0.893	0.875	0.909

Robust standard errors in parentheses

**** p<0.01, ** p<0.05, * p<0.1*

Annex 6. t-statistics of model (5)

Table A10(1). t-statistic of the catching-up term in equation (5)

Span \ Base	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Span
1	-2.9	-2.1	-2.7	-1.1	0.0	-3.4	-1.7	-1.9	-3.1	-2.2	-3.1	-3.3	-2.9	-2.3	-1.3	-1.4	-1.7	0.1	-1.0	1
2	-2.6	-2.9	-2.5	-0.7	-2.0	-4.0	-2.3	-2.8	-3.3	-3.0	-3.9	-5.0	-3.2	-2.5	-1.4	-2.1	-1.1	-0.6	-0.9	2
3	-3.5	-3.1	-2.4	-2.0	-2.8	-4.3	-2.8	-2.9	-3.6	-4.0	-5.2	-4.8	-3.1	-2.5	-2.2	-1.6	-1.5	-0.8	-0.9	3
4	-3.5	-3.2	-3.3	-2.7	-3.5	-4.8	-3.1	-3.3	-4.4	-5.2	-5.1	-4.5	-3.1	-3.1	-2.3	-1.9	-1.6	-0.9		4
5	-3.8	-4.1	-3.6	-3.4	-3.9	-5.0	-3.4	-4.4	-5.5	-5.1	-4.8	-4.3	-3.4	-3.2	-2.6	-2.0	-1.7			5
6	-4.6	-4.3	-4.3	-3.9	-4.2	-5.4	-4.5	-5.5	-5.3	-4.9	-4.8	-4.5	-3.5	-3.5	-2.8	-2.0				6
7	-5.0	-4.8	-4.7	-4.1	-4.7	-6.2	-5.5	-5.5	-4.9	-4.9	-5.0	-4.5	-3.6	-3.7	-2.9					7
8	-5.3	-5.1	-4.8	-4.7	-5.6	-7.8	-5.6	-5.1	-4.8	-5.2	-5.1	-4.5	-3.7	-3.8						8
9	-5.4	-5.4	-5.2	-5.5	-7.2	-8.0	-5.1	-4.9	-4.9	-5.3	-5.1	-4.4	-3.7							9
10	-5.7	-6.0	-6.1	-7.0	-7.6	-7.9	-5.0	-4.9	-5.0	-5.2	-5.0	-4.3								10
11	-6.0	-6.9	-7.5	-7.2	-7.4	-8.1	-5.0	-4.9	-4.8	-5.0	-4.8									11
12	-6.9	-8.4	-7.8	-7.2	-7.6	-8.4	-4.9	-4.6	-4.6	-4.9										12
13	-8.5	-9.0	-7.7	-7.4	-7.9	-8.2	-4.7	-4.4	-4.5											13
14	-9.0	-9.0	-7.9	-7.6	-7.7	-8.0	-4.5	-4.2												14
15	-9.1	-9.2	-8.2	-7.5	-7.4	-7.6	-4.3													15
16	-9.3	-9.5	-7.8	-7.2	-7.0	-7.3														16
17	-9.7	-9.1	-7.5	-6.9	-6.7															17
18	-9.1	-8.7	-7.2	-6.6																18
19	-8.7	-8.3	-6.9																	19
20	-8.2	-7.9																		20
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	

Table A10(2). t-statistic of the institutions term in equation (5)

Span \ Base	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Span
1	2.7	1.8	1.9	1.3	-1.7	1.8	0.1	0.7	0.9	0.1	0.0	1.1	1.1	1.1	0.1	-0.2	1.0	-0.8	-0.7	1
2	2.3	2.2	1.9	-0.1	0.1	1.5	0.6	0.6	0.8	0.1	0.8	1.9	1.4	1.0	-0.3	0.7	0.3	-0.7	-0.7	2
3	2.8	2.2	1.2	0.8	0.3	1.7	0.5	0.6	0.6	0.9	1.4	2.0	1.2	0.7	0.6	0.2	0.2	-0.7	-0.7	3
4	2.7	1.8	1.7	0.8	0.8	1.7	0.6	0.6	1.2	1.4	1.7	1.6	0.9	1.2	0.7	0.2	0.2	-0.6		4
5	2.5	2.1	1.6	1.2	0.8	1.6	0.5	1.4	1.5	1.6	1.5	1.4	1.3	1.3	0.9	0.2	0.1			5
6	2.8	2.0	2.0	1.2	0.7	1.5	1.2	1.7	1.5	1.4	1.3	1.6	1.4	1.4	1.0	0.2				6
7	2.7	2.2	1.9	1.1	0.7	1.7	1.5	1.8	1.2	1.2	1.6	1.6	1.5	1.5	1.1					7
8	2.7	2.1	1.6	1.0	0.9	2.1	1.7	1.4	1.0	1.4	1.7	1.6	1.6	1.6						8
9	2.5	1.9	1.3	1.1	1.1	2.3	1.3	1.2	1.2	1.5	1.8	1.7	1.6							9
10	2.1	1.6	1.2	1.3	1.3	2.3	1.2	1.2	1.2	1.5	1.8	1.6								10
11	1.7	1.4	1.3	1.3	1.4	2.3	1.2	1.2	1.1	1.5	1.8									11
12	1.4	1.5	1.1	1.3	1.5	2.4	1.1	1.1	1.1	1.5										12
13	1.5	1.3	1.1	1.4	1.5	2.4	1.0	1.0	1.0											13
14	1.2	1.3	1.2	1.4	1.5	2.4	1.0	0.9												14
15	1.0	1.3	1.3	1.4	1.5	2.4	0.9													15
16	1.0	1.5	1.3	1.4	1.5	2.3														16
17	1.2	1.4	1.3	1.4	1.5															17
18	1.1	1.4	1.3	1.4																18
19	1.0	1.4	1.2																	19
20	0.9	1.3																		20
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	

Table A10(3). t-statistic of the debt dummy term in equation (5)

Span \ Base	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Span
1	1.2	1.6	-1.5	-0.2	-2.1	-0.2	-0.8	-1.1	0.5	-1.7	-3.2	-0.5	1.4	0.3	-1.5	-1.7	-0.5	-1.6	-2.1	1
2	1.2	1.0	-0.2	-1.4	-1.1	0.0	-1.1	-1.1	-0.1	-2.5	-1.7	0.4	0.9	-0.5	-2.2	-1.2	-1.2	-2.0	-2.2	2
3	1.3	1.4	0.0	-1.0	-0.8	-0.5	-1.2	-0.9	-0.9	-1.2	-0.8	0.4	0.0	-1.0	-1.1	-1.6	-1.4	-2.2	-2.2	3
4	1.4	1.6	0.3	-0.9	-1.0	-0.9	-1.0	-1.1	-0.1	-0.7	-0.5	-0.4	-0.6	-0.5	-0.9	-1.6	-1.5	-2.2		4
5	1.9	1.8	-0.1	-1.1	-1.3	-0.8	-1.2	0.0	0.0	-0.5	-0.9	-1.0	-0.5	-0.3	-0.6	-1.7	-1.6			5
6	2.2	1.5	-0.5	-1.3	-1.2	-1.1	-0.2	0.2	0.0	-1.2	-1.3	-0.9	-0.4	-0.2	-0.5	-1.7				6
7	2.0	1.1	-0.9	-1.1	-1.5	-0.9	-0.1	0.3	-0.7	-1.7	-1.2	-0.8	-0.5	-0.1	-0.4					7
8	1.6	0.7	-0.7	-1.1	-1.2	-0.7	0.0	-0.4	-1.2	-1.7	-1.1	-0.9	-0.6	-0.1						8
9	1.1	0.8	-0.7	-1.0	-1.2	-0.5	-0.6	-0.7	-1.2	-1.7	-1.1	-1.0	-0.6							9
10	1.0	0.8	-0.4	-1.1	-1.2	-0.8	-1.0	-1.0	-1.4	-1.8	-1.1	-1.0								10
11	0.6	0.6	-0.5	-1.2	-1.2	-0.9	-1.2	-1.2	-1.6	-1.9	-1.1									11
12	0.5	0.6	-0.8	-1.2	-1.3	-1.3	-1.5	-1.4	-1.8	-1.9										12
13	0.5	0.5	-0.8	-1.3	-1.6	-1.2	-1.7	-1.5	-1.9											13
14	0.1	0.4	-1.0	-1.6	-1.6	-1.2	-1.8	-1.7												14
15	-0.1	0.2	-1.3	-1.5	-1.6	-1.2	-1.9													15
16	-0.4	-0.1	-1.2	-1.5	-1.5	-1.2														16
17	-0.5	-0.1	-1.3	-1.4	-1.5															17
18	-0.7	-0.1	-1.3	-1.4																18
19	-0.8	-0.2	-1.4																	19
20	-0.9	-0.2																		20
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	

Table A10(4). t-statistic of the interaction term in equation (5)

Span \ Base	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Span
1	-1.3	-1.4	0.4	-1.2	-0.7	0.4	0.4	0.0	0.5	0.3	0.7	-0.4	0.2	1.0	1.9	1.9	0.8	2.6	3.0	1
2	-1.0	-0.7	0.1	-1.0	0.0	0.4	0.1	0.7	0.2	0.6	0.0	-0.3	1.1	1.5	2.7	1.4	2.1	3.3	3.0	2
3	-1.0	-0.3	-0.4	-0.6	0.1	0.1	0.4	0.4	0.3	0.0	0.0	0.5	1.5	2.0	2.0	2.4	2.6	3.4	3.1	3
4	-0.7	-0.4	-0.2	-0.2	-0.1	0.0	0.3	0.4	-0.3	0.0	0.6	1.1	1.9	1.7	2.3	2.7	2.8	3.4		4
5	-1.1	0.0	-0.5	-0.2	-0.1	0.0	0.3	-0.3	-0.1	0.5	1.0	1.5	1.6	2.0	2.4	2.9	2.9			5
6	-1.0	0.0	-0.4	-0.2	0.0	-0.1	-0.1	-0.2	0.4	1.1	1.4	1.3	1.9	2.1	2.4	3.0				6
7	-0.8	0.1	-0.5	0.0	-0.1	0.1	0.0	0.3	1.1	1.5	1.2	1.7	1.8	2.1	2.4					7
8	-0.5	0.1	0.0	0.3	0.2	0.4	0.4	0.9	1.4	1.4	1.5	1.6	1.7	2.2						8
9	-0.3	0.5	0.5	0.6	0.5	1.1	0.9	1.2	1.4	1.8	1.5	1.6	1.7							9
10	0.2	1.0	1.1	0.8	1.4	1.4	1.2	1.4	1.9	1.8	1.4	1.6								10
11	0.9	1.5	1.3	1.5	1.6	1.6	1.3	1.8	2.0	1.8	1.4									11
12	1.4	1.8	2.1	1.9	1.8	1.9	1.7	1.9	2.0	1.8										12
13	1.6	2.8	2.4	2.2	2.2	2.0	1.8	2.0	2.0											13
14	2.5	3.1	2.6	2.6	2.2	1.9	1.8	2.0												14
15	3.0	3.4	2.9	2.7	2.2	1.8	1.8													15
16	3.4	3.7	2.7	2.5	2.1	1.8														16
17	3.4	3.5	2.6	2.5	2.0															17
18	3.4	3.4	2.4	2.4																18
19	3.4	3.3	2.3																	19
20	3.4	3.2																		20
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	

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