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Innovation and institutions: a symbiotic marriage?

A panel data approach to long-term GDP change and institutional reform

Master's thesis in Economics

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Abstract

This paper studies the long-term relationship between economic growth and institutional change. Using a dynamic panel data model, several tests are conducted to test for both long- and short-term movements in GDP, and institutional quality using annual data from 87 countries ranging from 1984 to 2016. This paper contributes with an econometric approach to long-term GDP change theory as several tests are conducted for both general long-term effects of institutional reform on GDP growth, geography-specific effects and an interaction test of productivity's and institutional reforms' combined effect on economic activity. This paper finds that both improved political- and economic institutional quality raise long-term innovation-driven growth. The causal relationship is found to be in the direction from institutional reform to economic growth.

Keywords: GDP, TFP, dynamic panel data, institutions, political reform

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1. Introduction

What characterises the last century compared to previous centuries is the pace of change (Schön, 2006). Since the first industrial revolution in the middle of the 19th century, the world economy has expanded at an unprecedented pace. However, the progress has not been linear but rather a cyclical process where the economy moves up and down, but persistently upwards over time. The growth rate has varied widely over time across longer periods than classical business cycles. Sustained periods of high growth have been followed by sustained periods of low growth (Piatier, 1981; Hall and Preston, 1988; Andersson, 2016). For instance, world GDP per capita growth averaged around 2.2 percent during the 1980s and 1.1 percent during the 1990s (World Bank). The underlying cause of these long waves in growth is often accredited to technological change (OECD, 2003; Andersson, 2016). Historical data indicate that innovation and productivity change tend to vary in longer periods ranging around 30-60 years, a pattern that could explain much of the long term economic changes (Berry, 1991; Schön, 2006).

A growing literature also stresses the importance of economic and political institutions (Bergh and Karlsson, 2010; Berry, 1991; Schön, 2006). During the last nearly 200 years the liberalisation of economies, markets and borders has increased, and consequently economic activity (Schön, 2006). Ever since the first one, industrialised economies have gone through several technological revolutions (Piatier, 1981; Schön, 2006), each of which has introduced a new techno-economic paradigm with a new set of generic technologies, infrastructure and organisational principles that have changed and modernised societies (Perez, 2007). At the end of the diffusion process, economies have entered long run structural crises with declining growth rates and increasing unemployment (Perez, 2007). Although increasing unemployment, and stagnant wages impose a welfare loss at the time, these periods have historically marked important turning points when new disruptive innovations have had their breakthroughs, causing growth to eventually increase again (Devezas, Linstone and Santons, 2005; Schön, 2006; Perez, 2007). Nevertheless, these revolutions might not just affect the supply side of the economy, but also institutions, countries' economic systems, and ultimately how people live their lives (Perez, 2007). A similar S-shaped movement seems to account for public opinions and the view of nationalism versus globalism, resulting in theories that the same long wave movement comes for institutions (Berry, 1991). However, these theories tend to be theoretical and lack empirical backing.

Therefore, this essay tests the direction of causality between institutional reform and long-term changes in GDP. In other words, whether long term changes in GDP could be explained by institutional reform, or if long term changes in the economy cause institutional change between the years 1984 to 2016. Searching for Granger causality in a dynamic panel data set of 87 countries, several tests are conducted. First, the relationship between long- and short-term institutional improvement and GDP growth is tested with GDP as the dependent variable, then the reverse with the individual institution as the dependent variable. As there might be a covariant relationship between innovation and institutional reform, where they depend on each other to cause substantial GDP growth, this relationship is tested. Finally, tests are conducted for different economic regions as there might be different patterns and relationships depending on the degree of economic development in different regions in the world.

Significant coefficients are found for changes in political and economic institutional quality, regulatory freedom and openness to trade causing growth. Results also show that reforms improving political and economic institutional quality both raise long-term innovation driven growth. Separate continent- and country-group specific effects are also found indicating that long-term change and institutional improvements have different effects on different economies depending on the degree of economic development. As no significant relationship between long-term change in GDP causing institutional reform is found, the general causal relationship is from institution to economic growth.

The rest of this thesis has the following disposition: Section 2 covers the background and theory of long-term growth and institutional quality, section 3 describes our hypotheses and how these will be tested, section 4 describes our data, its statistical characteristics and our use of method, section 5 presents our estimated results, which are analysed in section 6, and finally section 7 presents our conclusions.

2. Background

Since the late 19th century most of economic growth theory has focused on gradual equilibrium growth. In contrast to the theories of Schumpeter and as stated by Alfred Marshall "natura non facit saltum" – or "nature doesn't jump" (Marshall, 1892; Mensch, 2006). For the past five decades, the basic neoclassical Solow-Swan growth model has been the principal for macroeconomic analysis. The model explains GDP as a variable of capital investment, human capital and technological development where GDP growth is an endogenous factor with a natural equilibrium state (Knight, Loayza and Villanueva, 1993). The Solow-Swan growth model predicts that in steady-state equilibrium the level of per capita income will be determined by the prevailing technology, as embodied in the production function, and by the savings rate, population growth and technological progress. Such models predict a natural rate of growth where the role for policymakers is to avoid major deviations from the potential growth path. However, technological innovations and their effects on the economy rarely move in a linear pattern but rather in a S-shaped form (Berry, 1991; Schön, 2006). This phenomenon was first introduced by Nikolai Kondratieff who drew attention to them in 1925, using data on prices, wages and interest rates, as well as industrial production and consumption from France, Great Britain and the United States (Schön, 2006). Kondratieff's theory, which later came to be called Kondratieff cycles, was based around the waves of price fluctuations that could be observed from late 18th century to the early 1920s. By observing the relative prices of agricultural and industrial products he claimed that the rising prices of agricultural products led to the expansion of the rest of the economy during a capitalist system (Schön, 2006). The notion that the economy moves in long cycles was later adapted by Joseph Schumpeter who claimed that outstanding and revolutionary technological innovations came in clusters and triggered economic upswings.

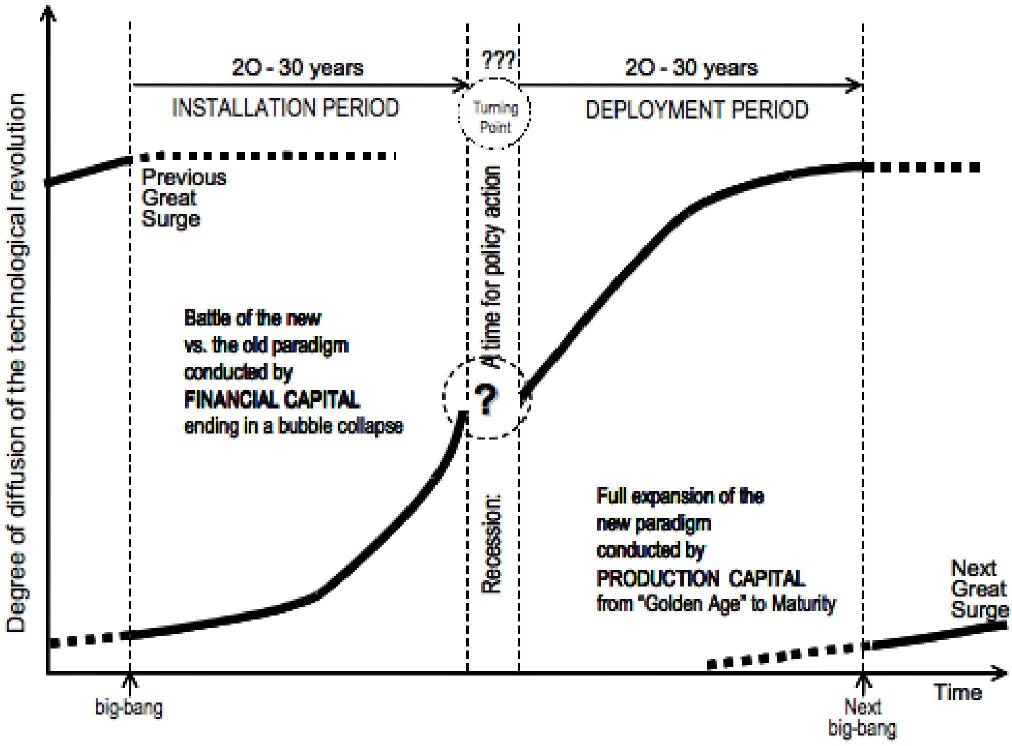
Using time-series of important indicators of general economic activity, it seems clear that long-term growth covering several business cycles, in developed countries and worldwide, is not steady and there are successive phases of accelerating and decelerating growth ending in recessions just to be followed by a new period of growth (Metz, 2005). World GDP per capita has moved from an average growth pace of 3.5 percent during the 1970s to 1.4 percent during the 1990s and now most recently an average of around 1.6 percent during the 2010s. After each of downturn the economy has bounced back and through the ashes of old firms and markets new products and companies have risen (Berry, 1991). In addition, through these shocks in the economy, countries' economic institutions are reformed. As economies face financial crises and banking crises often linked to recessions, the political urgency for institutional reform increases (Kaminsky and Reinhart, 1999; Andersson, 2016). Throughout history it has not primarily been after the first breakthrough of a technology that growth and disruption starts, but rather after the technology has been given time to mature and develop further (Schön, 2006). For instance, the first idea of the internet was drafted in 1962 and the first forms of internet was developed already in the early 1980s (Internet society, 1997), but its effect on the wider economy only started to emerge as late as the mid-1990s. In the early stage of an invention there are clear limits as the knowledge on how to use it is narrow and perhaps the infrastructure and common standards are yet to be imposed. This restricts the scope of the invention in its early stages. This time lag between initial invention, and widespread adoption and economic effect has lately been suggested to explain the so-called productivity paradox regarding the internet (Schön, 2006).

Between these waves of innovations, a remarkably timely distance occurs of around 30-60 years. Each of these clusters of innovation were developed during deflationary growth cycles, such as the most recent one (Berry, 1991). Each cluster produces significant growth in both GDP, productivity and in prices. However, this paper argues that these innovations were not the result of individual spurious innovation but rather an effect of surrounding factors (Hall and Preston, 1988, Berry, 1991 and Schön, 2006). Organizational-, institutional-, financial market- and state action all played a crucial role. Each of these innovations were also dependent on the development of infrastructural developments such as railways, electricity grids, highways, airports, education and access to investments. This required both high levels of capitalization, infrastructure and technical standardization (Berry, 1991). Some argue that the key innovation is venture capital itself (Berry, 1991).

Longer economic time series show an economic movement in long S-shaped cycles in three stages: innovation, rationalization, and crisis. Through this process first a new set of innovations that create new products, services and markets, comes a second phase of rationalization where the same innovation is used to increase the productivity of existing products and services. However, history seems to also show a third phase, namely the "bust-phase". The years before a crisis are characterized by rationalization and cost minimization primarily for established and often longstanding companies, products and markets. This ultimately comes to an end, where the lack of renewal forces the old firms to either reinvent or go bankrupt. However, during this phase investments would still be high as capital levels continue to increase and ultimately – as the investments in unprofitable businesses run short – a recession occurs. It takes such a crisis for new technology to have its full breakthrough and for the economy to once again focus on renewal and innovation rather than rationalization (Schön, 2006). This pattern seems to be reoccurring as the world have experienced several structural crises such as the late 1840s, beginning of the 1890s, early 1930s, the middle of the 1970s and now most recently during the financial crisis that erupted in 2008. During the latest global financial crisis, a contributing factor was the easy credits allowed, causing increasing asset prices and unsubstantial debt levels (Schwartz, 2009).

These technological steps can be called general-purpose technologies (Schön, 2008) or macro-innovations. Such a technology first spreads to most sectors of the economy, then improves over time and finally facilitates invention and creates new products and processes. Such innovations are rare, there are only two such technologies during the last two centuries; electricity and ICT (Jovanovic and Rousseau, 2006). The implementation of such a disruptive technology requires two development waves: in the first cycle, the innovation affects the production process, and in the second development it creates a "revolution in consumer products" (Tunzelmann, 2003; Perez, 2007). This long-term economic movement is not a singular event but rather several parallel processes. As one technique's potential is maximized another develops (Perez, 2007). This pattern is illustrated below in figure 1.

Figure 1. Illustration of long-change movements in innovation and productivity



Source: Perez, 2007

Modern econometrics has found mixed results regarding econometric time-series proof of long-wave movements but robust evidence has been found for clusters of economic activity (Metz, 2005; Devezas, Linstone and Santons, 2005). Summarizing for innovations from 1750 to 1991 show clusters of innovation peaking in 1840, 1890, 1935 and 1986. Mapping these clusters together with economic activity has shown a lagged upswing in growth with a time-lag about 18 years (Mensch, 1979; Metz, 2005). Innovation clusters that lie well in line with famous innovations. Before 1800 the mechanization and automatization of the textile industry caused a first industrial transformation. Steel and electricity together caused up and downswings from around 1850 to

1920. Oil and subsequent technologies caused a third technological upswing ranging around 1920 to 1970. Since then the latest wave of innovation has clearly been information and data techniques resulting in automation and efficient communications starting about 1970 to the present (Perez, 1983; Linstone and Mitroff, 1994; Devezas, Linstone and Santons, 2005).

During these clusters of innovation different countries progress during different eras as innovations seem to start in some core countries that become technological leaders and then their innovations spread to other countries. For example, the leaders in the steam powered transportation era were Britain, France, Belgium, the United states of America, and Germany, and the followers were Italy, the Netherlands, Switzerland and Austria–Hungary. The technological leaders of today are the U.S., Japan, the European countries, Canada, Australia, South Korea and Taiwan (Devezas, Linstone and Santons, 2005). This indicate that there are country-specific factors that contribute to a country's ability to adapt and nurture innovation and growth.

Over the last 30 years, information and communications technology (ICT) has been the main technological engine behind growth in the world economy (Jovanovic and Rousseau, 2006; Perez, 2007). But, there are signs showing that the speed of growth caused by ICT is slowing down. For example, in 1985 the rate of return of one unit of ICT capital was 5 times higher than the rate of return on other productive capital (Andersson and Karpestam, 2012). Following a large expansion of the ICT capital stock, the rate of return compared to other kinds of capital was reduced to 1 in 2007 (EU KLEMS).

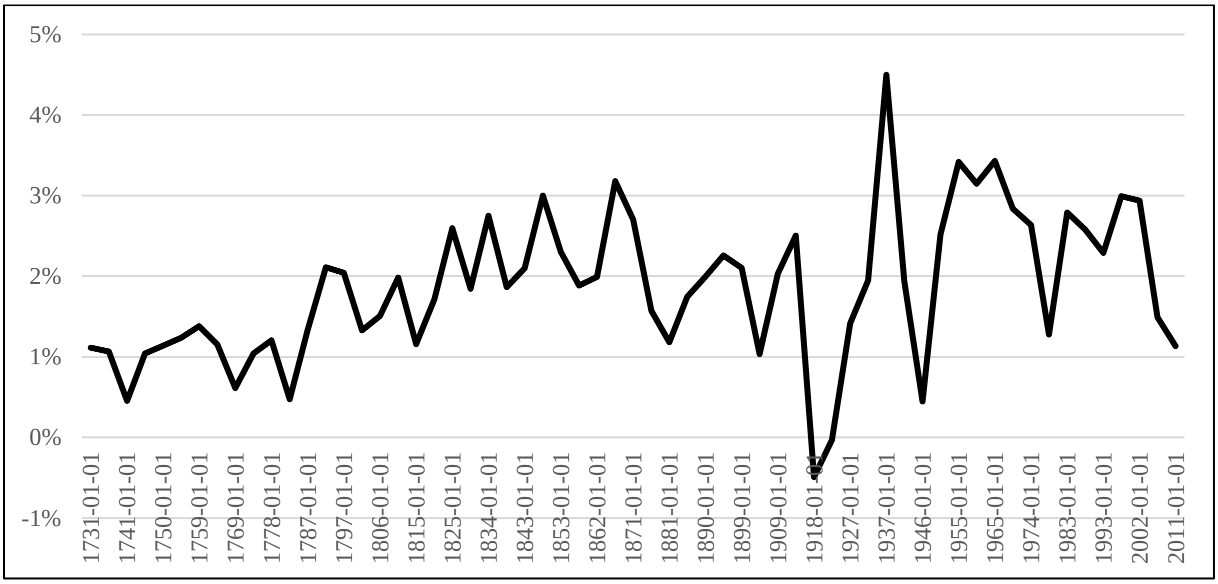
Table 1. Average productivity growth

US Total Factor Productivity		**Swedish Labour Productivity Growth**	
Year	*Average annual growth rate*	*Year*	*Average annual growth rate*
1870-1900	1.5%-2%	1896-1910	1.5%
1900-1920	1%	1910-1935	2.9%
1920s	2%	1935-1950	2.1%
1930s	3%	1950-1975	5.4%
1940s	2.5%	1975-1990	2.3%
1950-1973	2%	1990-2005	5.9%
1973-1990	< 1%		
1990s	> 1%	1896-2005	3.0%
2000s	1.5%		

Source: Shackleton (2013) and Schön (2006: Schön (1990) and Swedish Statistics)

Table 1 shows that a similar pattern can be seen for longer series of productivity as clear wave-like movements occur. Just as for TFP, when examining GDP there are clear patterns of waves. By smoothing for yearly averages, extreme values can be avoided, and trends shown (Berry, 1991). Figure 2 shows the computed nine-year average and the annual change of real GDP in the UK since 1710, and throughout history its economy has persistently moved in waves. Previous studies of long waves have not included the latest years surrounding the financial crisis of 2009. But, as seen in figure 3, also the latest years' economic turbulence can be understood through long-term change theory. This suggest that it is not a matter of statistical coincidence but rather the economy moves in trends and the smoothing technique tracks underlying movements in the growth rate by separating signals from noise (Berry, 1991).

Figure 2. Annual change in UK real GDP, 9-year moving average



Source: Bank of England

Plotting the latest 150 years of growth into a scale of before and after an initial deep fall in GDP growth shows how growth rates tend to move in 30-60 year cycles, but these cycles, at least for the United Kingdom, appear to be increasingly longer. Similar results have been found by Berry, Kim and Kim (1993) and Schön (2006).

Figure 3. Annual change in UK real GDP, 9-year moving average, years surrounding fall in GDP growth

Source: Bank of England

Still economic growth is not a guarantee although long-term changes exists – political factors also plays a big role (Berry, 1991; Bergh and Karlsson, 2010). Government size and quality has been debated for a long time. Recent studies suggest that there is a negative correlation between government size and economic growth (Fölster and Henrekson, 2001; Bergh and Karlsson 2010). This case is strengthened by research that show how economic and regulatory freedom cause growth to thrive (Dawson, 1998). Although this is a most central discussion institutional quality is often needed in an early phase of a country's development. Rule of law, contract enforcement and non-corrupt government institutions has been found to have profound effects on growth as these lay out the most basic infrastructure for exchange of goods and money (Dixit, 2009). Evidence from Sweden and USA has also shown that stable monetary policy with functioning inflation-control plays a central role in growth (Bergh and Karlsson, 2010). Although it is against the case of a smaller state, comparing the high taxed Sweden with USA at the 1980-2000 period show that Swedish growth exceeds American. The explanation seems to be found in inflation-control as Sweden lowered annual inflation from 10 to 1 percent, roughly adding another percentage point to average annual growth. USA, in contrast, only lowered inflation from 7.2 to 2.5 over the same period and a slower growth. Since the origins of Adam Smith economists has concentrated on comparative advantages resulting in the Heckscher-Ohlin model of trade theory. This theory states that the welfare gains are greater if two countries specialize on its comparative respective comparative advantage rather than produce a mixed bundle of goods and then trade each surplus for the other's (Feenstra, 2004) A relationship confirmed in modern studies (Lee Ha et al., 2004). However, ideas and influences might also be of contribution to other countries through free exchange of ideas and non-economic corporation. Such a friendly and open-minded state might very well also have positive effects on growth (Abramovitz, 1986; Dreher, 2006).

3. Long term GDP-movement and institutional reform

Exogenous growth theory today focuses on a longer-term perspective where technology and innovation drive growth through periods of growth and stagnation. This causes GDP growth to move in cyclical shapes rather than linear, also in the long run. Radical innovations can cause technological revolutions because these pave the way for new complementary innovations and activities, which reinforce each other (Schön, 2008). A structural change model is not bounded by limitations imposed by a general equilibrium theory, instead it includes the dynamics of structural instability and structural readiness for breakthroughs of innovation and exogenous events (which can have positive and negative effects on the economy) (Mensch, 2006). This model treats production not merely as a Keynesian function of investment and consumption, where output is a function of labour and capital input. As autonomous investors plan investments that change the production process within the economic subsystem the model treats investments as a function of expected demand. Industrial investors form dynamical expectations such that if the expected potential over time is non-linear but structurally stable, then it is a function that follows a unit-root, but if the system is unstable it follows three unit roots (Mensch, 2006). Therefore, growth is not a linear-function of invested capital and labour input – but rather a function of the combination of input and exogenous shocks. These shocks are radical innovations that cause unit-root jumps.

Not all innovations cause industrial revolutions despite having impacts on a market. To distinguish between the two, there are micro- and macro-innovations (Mokyr, 1994). Micro-innovations are improvements within the present techno-economical paradigm while macro-innovations are disruptive new ideas causing completely new production methods and industries (Grübler och Nakicenovic, 1991; Jovanovic and Rousseau, 2006). Recent literature takes this theory one step further, linking social and institutional development to innovation and growth. It is not guaranteed that macro-innovations reach their potential as they, just as any innovation and company, are dependent on several surrounding factors. These can be access to financing, regulatory factors as well as barriers of entry – broadly speaking the political institutional system. Empirical evidence can be found for reforms such as environmental taxes or other reforms incentivising renewable energy initiating a positive effect on innovation in "green technologies", which speeds up the diffusion process of existing technologies (Lanjouw and Mody, 1996; Jeffe and Palmer, 1997; European Environmental Agency, 2011; Andersson and Karpestam, 2012). Economic long-term development could therefore be just as dependent on its institutions as the institutions depend on the economic development. The exogenous growth model therefore takes a much more complex form than classical growth models, as it includes not only endogenous and exogenous factors. As technologies develop and old ones are being replaced by new ones, regulations and public infrastructure become obsolete (Bresnahan and Trajtenberg, 1995; Lipsey, 2009). In recent history ICT has forced policymakers to address new regulatory issues regarding both property rights and financial regulation. Innovations and long run economic change correspondingly stimulates institutional change, causing the relationship to work both ways.

Although innovations tend to widely known, there are still differences in the degree of implementation of innovation into the economy, as some countries tend to be more prone to innovation than others. It might not only be a cause of technological and macroeconomic factors but also institutional and societal factors that contribute (Schön, 2006). Although similar fiscal and monetary reforms were conducted in a comparable timeframe, some European countries have had a higher GDP growth than other countries, explained by more significant contributions from ICT to GDP – strengthening the case that it is not only simple linear relations between investment in education and capital that nurture growth, but rather a highly-complicated relation (Andersson, 2015).

As there are clear evidence of wave patterns the question arises: what drives the other? Does policy change affect the real economy's ability to innovate and implement new technology, or are there economic factors that force politicians to act on new policy affecting the real economy? And what kind of policy best enables not only the development but also the implementation of new techniques, creating increased growth? And how does globalisation and the degree of economic openness enable countries to adapt to, and gain from new technologies? To address these questions, four key hypotheses are outlined below.

Hypothesis 1. *Long-run institutional reform causes long-term improvements in economic growth.*
The economic life-cycle has been well described by Abramovitz (1986) "Catching Up, Forging Ahead, and Falling Behind". Such life-cycle argues that the key to the growth is a country's ability

to import and implement technology from a more technologically advanced country. The growth rate of a developing country will be higher than the growth rate of a developed country because the diminishing returns of developing countries is much lower. By employing optimal policies, the developing country could then exceed the developed, or forge ahead, just to become developed to see a developing country use their technology and grow faster. This theory also indicates that different institutions are required for different innovations and stages in a country's phases of economic development. Prior research has found that institutional quality has growth-enhancing effects on GDP as a sound business climate, trustworthy political institutions and clearly defined property rights enhance business investment and entrepreneurship (Cavallo and Cavallo, 2010; Acemoglu and Robinson, 2012). A similar pattern seems to occur for the opposite as recessions and financial crises can be caused by bad institutions and poor policy decisions (Kaminsky and Reinhart, 1999). Increased openness to trade and to foreign influences and ideas will in theory increase the probability that a country discovers or develops new technologies and inventions, which improves the country's long-term growth path (Bergh and Karlsson, 2010). But does this relationship hold for long term improvements in GDP? Recent literature suggests that there are other factors in addition to traditional institutional quality that affect GDP growth, such as innovations arising irrespective of institutional quality, as well as human capital (Glaeser, La Pota, Lopez-de-Silanes and Shleifer, 2004; Andersson, 2015). To investigate for relationships, tests are conducted using both the level of public resources invested in education as well as several indexes measuring institutional quality for political- and macroeconomic stability, degree of political and economic globalisation, and the degree of regulatory freedom.

Hypothesis 2. *Long-changes in the economy cause growth enhancing institutional reform.*

As economies slowly accelerate or decelerate, public opinion and regulatory demand shifts. The invention of the internet was at first merely a new fling but today it has prompted new privacy legislations, intellectual property rights and border issues in terms of capital movements and much more. Economic activity could therefore cause changes in institutions, as well as major policy changes and reforms (Claessens, Klingebiel and Leaven, 2002). Studies have found that election results of presidents in USA are moving in a cyclical pattern as Republican presidents seem to be elected during low-growth periods and Democratic presidents during periods of high growth and rising inequality (Berry, Elliott, Harpham and Kim, 1998). This indicates that long term movement in the economy affects what sort of policy that are demanded by the electorate, consequently resulting in the election of politicians delivering reforms in such manner. Such a pattern is also evident in the relationship between slow economic progress and the consequent rise of populist politicians (Dornbusch and Edwards, 1990). If a country enters a lower long-term growth path public opinion, with the previous higher growth still in mind, will ultimately demand policy actions that causes growth to increase again. To test for such a pattern several indexes measuring institutional quality are tested with long and short-term GDP growth to investigate for clear patterns indicating that long term changes in economic activity cause institutional reform.

Hypothesis 3. *Co-dependency is required between new technology and institutional reform for either to have a long-term effect on GDP.*

So far, the theory has been that the relationship is binary; either institutional reform affects GDP, or long-term movements in GDP affects institutions. But it may well be that they are dependent on each other. For a new technology to have a full impact some institutional qualities are required (Lipsey, 2009). However good a disruptive innovation might be, access to financing, and possibilities to export and to enter new markets without too much regulation might very well be required. Nevertheless, it might also be the case that deregulation and easy access to capital might not yield a higher amount of innovation or for that matter then a higher long-term growth. To test for this co-dependency extra variables are created estimated as the total factor productivity growth multiplied by each explanatory variable. The TFP is measured as the G7 average assumed to be a general market leading proxy for innovation. This new variable will then show if a combination of the two yields a higher effect or not.

Hypothesis 4. *Long-term change and institutional reform is a causal relationship that only can be found within developed countries.*

A possible explanation of long-term changes in the economy is such that it is a phenomenon for developed countries that are both interacting and dependent on each other and one's innovation and new technologies. It might very well be that the theory of Abramovitz (1986) still holds that the countries forging ahead and leading innovation are the ones affecting and driving long-wave movement forward, while the rest simply follows. Potentially, such a relationship does not exist for developing countries. Developing countries might still be struggling to get fundamental democratic and market-orientated institutions settled, often haunted by civil wars and economic turmoil. A counterargument would be that the opposite ought to occur, since developing countries have less to lose and more to gain by adapting quickly to innovation and thus can gain more than developed countries already settled and content with the status quo. This final hypothesis is tested by dividing the panel data into region-specific panels and then testing our first hypothesis for each sub-group.

4. Data and methodology

The hypothesis testing is conducted using a dataset of 87 countries including both developed and developing countries (for full description of data and a list of countries see Appendix B and B). The selection of countries has been conducted with respect to data availability, and includes data in the timespan of 1984-2016. Although the timespan is limited the data generally still accounts for over 30 years of observations. This period is obviously in the lower range of desired time length but compared to previous studies this is a data-driven study and by using the method of dynamic panel data estimation we can still hope to find valuable conclusions from the last structural change cycle (Berry, 1991; Schön, 2006; Perez, 2007). If evidence is found then we will be able to state that such results account for the latest long-change cycle and not for a universal period. If there are long-term effects such can thus still be found, but if they are not found then we can state that no such effects exist. As the theory of long-term movement state that it is a binary phenomenom, either it exists or it does not, so if no proof is found for the latest period then the theory does not hold (Schön, 2006: Perez, 2007). The wide range of countries ought to increase the robustness of our tests.

The econometric hypothesis testing is computed using a linear dynamic panel-data model where the unobserved panel-level effects are correlated with the lags of the dependent variable. The model also accounts for moving-average correlation in the idiosyncratic, or unsystemic, errors, which means that country-specific effects will not affect the estimate (Baltagi, 2013). In other words, if a single country experiences an anomalistic and rare event this one deviation will not affect the total estimate. To capture the effects of long waves without risking omitted results the model measures both the long- and short-term effects. These effects are computed by dividing our initial variable into a long-term moving average effect and the short-term deviation from this long-term effect.

We test for real GDP growth as the dependent variable, but also include five separate institutional indexes. GDP is measured as real GDP at constant 2011 national prices with the source from Penn World tables. To test hypothesis 3, we also use TFP and this is measured as TFP at constant national prices (index 2011=1) gathered through the Penn World tables. Our index estimate political institutions (IRCG political risk index), economic institutions (ICRG economic risk index), economic freedom index (Fraser institute of economic freedom), the economic openness (KOF index of trade and capital restrictions), and finally the degree of globalisation (the KOF index of political globalisation). These indexes have been used in several previous studies to measure institutional quality (Fölster and Henrekson, 2001; Catrinescu, Leon-Ledesma, Piracha and Quillin, 2009; de Haan, Sturm and Zandberg, 2009; Bergh and Karlsson, 2010; Andersson, 2016). Each index can be expected to affect growth in its own way: political quality describes the quality and trustworthiness of contracts and official governance, often crucial for a function market where contracts can be enforced and the government can be trusted (Dixit, 2009). Economic institutions estimate the stability of fiscal and monetary policy – perhaps an area where dysfunctional policies cause larger negative externalities than the positive outcomes of sound policies. Uncontrolled inflation is such an example of a factor causing negative effects on growth (Bergh and Karlsson, 2010). Economic and regulatory freedom is generally regarded as a contributing factor to the ease of starting and developing companies and thus for entrepreneurs and growth to thrive (Dawson, 1998). As there is some debate on the effects of globalisation this paper uses two sub-indexes of the KOF Globalisation index. Economic openness and growth is a relationship easier understood through fundamental macroeconomic theory and previous research has found evidence for such a relationship (Lee Ha et al., 2004). Some studies also find evidence for a causal relationship between political openness and growth and therefore this index is also included (Dreher, 2006).

The Fraser index measures the degree to which the policies and institutions of countries are supportive of economic freedom. Measuring the degree of personal choice, voluntary exchange, freedom to enter markets and compete, and security of individuals and privately-owned property. A higher score indicates a greater level of economic freedom. As the Fraser index only offers data in five year intervals leading onto year 2000, annual data has been estimated using linear interpolation. The index measuring Political Risk is constructed such that the healthier the institutions, the higher the score. The same applies to the index measuring Economic Risk, which is based on sub-indexes measuring debt levels, inflation and the current account, where a healthier financial system is rewarded with a lower risk and thus a higher score. These three indexes will measure the degree of liberalization of markets and competition, the robustness and accountability of a country's political system and finally the stability of its financial institutions such as quality of a central bank and treasury. The two KOF globalisation indexes are separated between political and economic openness. The political index is measured primarily on international diplomatic engagement and the economic index measures how open a country is towards foreign trade and capital movement, these two also reward a higher degree of openness with a higher score. Table 2 summarizes the sub-indexes constructing each index.

Table 2. Institutional indexes and their respective sub-indexes

ICRG political risk index	ICRG economic risk index	Fraser index of economic freedom	KOF trade and capital restrictions	KOF political globalisation
Government stability	Inflation	Size of government*	Mean tariff	Number of embassies and high commissions in the country
Socioeconomic stability	GDP per capita*	Legal system and property rights	Hidden import barriers	Number of international organizations that the country is a member of
Investment profile	GDP growth*	Sound money*	Taxes on international trade	
Internal conflict	Budget balance	Freedom to trade internationally	Capital controls	Number of UN peace keeping missions that the country participates in
External conflict	Current Account as % of GDP	Regulation		
Corruption				
Military in politics				
Religious tensions				
Law and order				
Ethnic tensions				
Democratic accountability				
Bureaucratic accountability				

Sub-indexes marked with * have been excluded from the index in the empirical analysis because they measure the same variable as our dependent variable and the economic outcome rather than reforms controlled by the policymaker.
Source: Andersson, 2016

4.1. Descriptive statistics

Table 3 show the descriptive statistics for our variables. In general, we can see that political risk is lower than economic risk, indicating that the development of democracy and stable governmental functions has been less successful than that of economic institutions. The opposite is true when it comes to globalisation, as countries tend to be more politically rather than economically open to other countries. In general, the standard deviations from mean are quite modest but for GDP growth and the control variable education expenditures, who show high standard deviations. Although we use data for countries with a high degree of economic and cultural diversity, each country's individual data shows robustness, and in general our data shows no signs of extreme anomalies.

Table 3. Country average volatility and general statistics of test data

Variable	Mean	Standard deviation (actual and share of mean)	Observations	
TFP	0,4%	0,3%	N=	1914
		82%	n=	87
			T=	22
GDP	4%	5%	N=	2610
		147%	n=	87
			T=	30
Political risk	5,6	1,3	N=	2871
		23%	n=	87
			T=	33
Economic risk	7,6	2,0	N=	2523
		27%	n=	87
			T=	29
Freedom index	6,3	1,5	N=	2547
		23%	n=	85
			T=	30
KOF Trade and capital	59,2	23,0	N=	2559
		39%	n=	83
			T=	31
KOF Political globalisation	69,7	19,0	N=	2621
		27%	n=	85
			T=	31
Ecucation expenditures	4,7	2,7	N=	2194
		57%	n=	85
			T=	26

Testing for heteroscedasticity using a Modified Wald test for groupwise heteroscedasticity in fixed effect regression model indicated presence of heteroscedasticity. Therefore, robust standard errors have been introduced into our model (See Appendix C).

Unit root tests has been conducted via the Fisher-type test as we are dealing with unbalanced data. Here the test has been conducted using both Augmented Dickey-Fuller test and the Phillips-Perron unit-root tests as the methodology might affect the result (Choi, 2001). In the ADF test, the lag length is included to solve the problem of autocorrelation. The regression also includes first differences as we are dealing with fixed effects. The unit root testing showed general significant results to reject the null hypothesis of non-stationarity and thus that the series are stationary in their original form (for full results see Appendix D). To test for not only correlation but causation we also test for pairwise Granger causality (for full results see Appendix E) finding significant causation between our explanatory and dependent variables.

Table 4. Contemporaneous correlation coefficients

	GDP	TFP	Polrisk	Ecrisk	FreeX	KOFTCR	KOFPG	EduExp
GDP	1.0000							
TFP	-0.0341	1.0000						
Polrisk	-0.0272	0.1103***	1.0000					
Ecrisk	0.0892***	0.1412***	0.6266***	1.0000				
FreeX	0.2873***	-0.0451**	0.2179***	0.2920***	1.0000			
KOFTCR	0.1149***	0.2558***	0.7058***	0.5074***	0.2483***	1.0000		
KOFPG	0.2072***	-0.0321	0.4770***	0.4130***	0.2856***	0.4443***	1.0000	
EduExp	-0.0884***	0.1113***	-0.0484**	-0.0973***	0.0733***	-0.0323	-0.0434**	1.0000

*, ** and *** denote significant estimates at the 10, 5 and 1 % significance levels respectively
Each variable is defined as the relative change from the previous period

As seen from Table 4 our Contemporaneous correlation coefficients showed significant correlation allowing us to move forward with our estimate.

4.2. Model specification

Estimating the effects of institutions on countries, there are plenty of time-invariant characteristics unique to the individual country that should not be correlated with other individual characteristics. So, as each country is different we allow for fixed individual effects. The combination of fixed country specific effects and a dynamic model might result in an endogeneity problem. This is solved by using a regression with a robust GMM estimator (Windmeijer, 2005; Bund and Windmeijer, 2010; Andersson, 2016). The Arellano-Bond (1991) and Arellano-Bover (1995)/Blundell-Bond (1998) dynamic panel estimators are general estimators that are appropriate when a model has short time periods and larger country dimensions, a linear functional relationship, a dynamic dependent variable, fixed effects and risks heteroscedasticity and autocorrelation.

The model is specified as a system of equations, one per time-period, meaning that time-specific effects are adjusted for. Each variable is estimated as the relative change from its previous period and GDP is estimated as real GDP. The long-term effects are computed using the same technique as in spirit of Berry (1998) and Andersson (2016) by changing the data from yearly to a nine-year moving average, computed as the average over the yearly observations. Such nine-year averages would account for the longer swings in the economy as GDP (Berry, 1991). By using nine-year data, short-term fluctuations are being removed, allowing the analysis to focus on the long-term movement. This allows us to estimate both short-term deviations and long-term effects. The first period is between 1984-1993 and the final between 2007-2016 or 2005-2014, depending on the data source.

There are several ways of estimating long-term effects on GDP but to avoid a debate on the estimation technique itself, long-term effects has been calculated as a weighted 9-year average (Berry, 1991; in spirit of Andersson, 2017). Using a weighted-average, instead of for example Wavelet analysis, allows us to fix the long-term estimate as this is what we are investigating. By using our decided method, we do not risk causing multiple definitions of wave-lengths and thus we would not risk assessing shorter or longer periods (Liu, 2011). Another possible way would be to use a Hodrick-Prescott filter to create a multiplier of time-trend. This has been discarded as such a method would risk producing series with spurious dynamic relations that have no basis in the underlying data-generating process (Hamilton, 2017). The computed long and short-term variables are specified as

$$X_{it} = X_{it}^S + X_{it}^L \qquad (1)$$

$$X_{it}^L = \frac{1}{N}\sum_{i=-4}^{4} X_{it-i} \qquad (2)$$

$$X_{it}^S = X_{it} - X_{it}^L \qquad (3)$$

where X_{it} denotes the original value of the variable and the short and long-term effects are denoted X_{it}^S and X_{it}^L. The short-term effect is computed as the deviation of the variable at time t from its long-term trend. The trend is computed as a weighted average between the current year and four years back and four years forth. This computation allows us to capture longer movements and filter for short-term deviations. The basic model is specified as

$$GDP_{it} = \beta_1 GDP_{it-1} + \beta_2 Index_{it-1}^S + \beta_3 Index_{it-1}^L + \beta_4 education_{it-1}^S + \beta_5 education_{it-1}^L + \delta_{it} + \varepsilon_{it} \qquad (4)$$

where i denotes country, t denotes time, index denotes one of the four institutional indexes, δ_{it} is a country-specific effect, and $\beta_2,\ \beta_3$ are the parameters that we are interested in. As our hypothesis suggests, there might hide a reversed causality as institutions might cause changes in GDP in a first step resulting that the change in the dependent variable cause a change in institutions. As the explanatory variables are all estimated with a time-lag we minimize the risk of endogeneity. A problem that could arise with economic time-series data is time-specific effects who cannot be explained by our variables, such events are excluded for by imposing time dummies for each estimated year[1].

To test for validity and robustness of our model we test for the Wald Chi-squared and the Arellano-Bond test for autocorrelation. The GMM estimator can produce consistent estimates only if the moment conditions used are valid. There is, however, no method to test if the moment conditions from an exactly identified model are valid beyond doubt but it is possible to test whether the overidentifying moment conditions are valid. The Wald Chi-square test is used to test the null hypothesis of all coefficients except for the constant being zero (Arellano and Bond, 1991). The Arellano-Bond test for autocorrelation test the null hypothesis that the errors in the first difference regression exhibit no autocorrelation.

5. Econometric analysis

Three different model specifications are being used in ranking order of the hypotheses. The first model estimates the effects institutions have on Gross Domestic Product. Then five different models are being set up controlling for the long-term effects GDP has on reform of institutions. Finally a interacting model is constructed to try and capture the co-dependence between innovation and institutional reform. Each model includes fixed time- and country specific effects. The models are all dynamic and therefore estimate the lagged effect of both the dependent and the explanatory variables (Andersson, 2017). As the dependent variable GDP might also be affected by the human capital level of the labour force, a control variable measuring government expenditure on education as a share of total GDP has been added (Solow, 1956; Florida, 2002). General government expenditure on education[2] is expressed as a percentage of GDP. General government usually refers to local, regional and central governments, the data is summarised by UNESCO and where there are missing values these have been estimated using linear interpolation.

Hypothesis 1.

When estimating and testing our first hypothesis we test using our initial model

[1] As the results are of no interest for this essay we do not show these results. These can happily be distributed by the author upon request.

[2] Current, capital, and transfer expenditures and the ratio also includes expenditure funded by transfers from international sources to government.

$$GDP_{it} = \beta_1 GDP_{it-1} + \beta_2 Index^S_{it-1} + \beta_3 Index^L_{it-1} + \beta_4 education^S_{it-1} + \beta_5 education^L_{it-1} + \delta_{it} + \varepsilon_{it} \qquad (4)$$

where GDP is tested as the dependent variable of institutional change. We use five indexes: political- and economic risk, freedom index, political- and economic openness, each estimated as short- and long-term.

Table 5. Regression results for Hypothesis 1.

	Variable	Coefficient
	Political risk, t-1	.1137003
		(.0803338)
	Economic risk, t-1	.0263755
		(.0816263)
	Freedom index, t-1	.2608746
Long-term effects		(.2614115)
	KOF Trade and capital, t-1	.0328362**
		(.0156003)
	KOF Political globalisation, t-1	.0623125
		(.1079742)
	Education expenditures, t-1	.2304161**
		(.1000686)
	Political risk, t-1	.0157567**
		(.0079328)
	Economic risk, t-1	.0327835
		(.0303745)
	Freedom index, t-1	-.0491273
Short-term effects		(.0916621)
	KOF Trade and capital, t-1	-.0034199
		(.0049902)
	KOF Political globalisation, t-1	-.0171349
		(.0131681)
	Education expenditures, t-1	-.0474961
		(.0291353)
	Dependent variable, t-1	-.2035193***
		(.028353)
	Constant	.0224114***
		(.0085288)
	AR (1)	0.0011
	AR (2)	0.0317
	Wald chi2	859.96 (13)
	Prob	0.000

*, ** and *** denote significant estimates at the 10, 5 and 1 % significance levels respectively
Standard errors are presented in parentheses below the parameter estimates

p-Values are presented for the AR-tests and the degrees of freedom for the Wald test are presented in parenthesis

We find significant results capital (at 5 % significance) suggesting that improved openness to trade and investments in education have positive long-term effects on GDP. Short-term estimates indicate that political institutional reform show a minor growth enhancing effect (at the 5 % significance level).

Hypothesis 2.

To test hypothesis 2 our model is reversed and the institution, described as index, will be the dependent variable of long-change movements in the economy, measured as long- and short-term GDP growth. The two long- and short-term effects are calculated as described in equation 1-3, allowing us to estimate long-term GDP growth. Each of our five indexes are estimated including a lagged dependent variable

$$Index_{it} = \beta_1 Index_{it-1} + \beta_2 GDP^S_{it-1} + \beta_3 GDP^L_{it-1} + \delta_{it} + \varepsilon_{it} \qquad (5)$$

where we are investigating particularly the estimates $\beta_2,\ \beta_3$.

Table 6. Regression results H2 test

		Political risk	Economic risk	Freedom index	KOF Trade and capital	KOF Political globalisation
Long-term effects	GDP, t-1	.1188616	.6373045	.0904811	.6449342	-.0694952
		(.2410495)	(.5970928)	(.130027)	(.6091517)	(.2238668)
Short-term effects	GDP, t-1	-.1387352**	-.0992647	-.013869	-.084737	-.0168486
		(.0671178)	(.1871163)	(.0379004)	(.1146523)	(.0425677)
	Dependent variable, t-1	-.8958483***	-.7028899***	.0128859	-.6818458***	-.8191155***
		(.0237398)	(.039196)	(.1736673)	(.0291161)	(.0426447)
	Constant	.0911052***	.0961631***	.0029597	.2334511***	.1429982***
		(.017473)	(.0247716)	(.0047083)	(.0552607)	(.0176583)
	AR (1)	0.0002	0.2453	0.0150	0.0003	0.0283
	AR (2)	0.0000	0.0000	0.7356	0.0600	0.0000
	Wald chi2	4081.12 (23)	1536.68 (23)	178.37 (23)	1883.28 (23)	2262.65 (23)
	Prob	0.0000	0.0000	0.0000	0.0000	0.0000

*, ** and *** denote significant estimates at the 10, 5 and 1 % significance levels respectively
Standard errors are presented in parentheses below the parameter estimates
p-Values are presented for the AR-tests and the degrees of freedom for the Wald test are presented in parenthesis

We only find significant results (at the 5 % significance level) for short-term GDP growth and political risk. Aside from this we do not find any significant relationship, meaning that the second hypothesis is rejected; long-term economic change does not seem to have a profound effect on institutional change.

Hypothesis 3.

As there might be patterns of long-term change in GDP not caused by institutions but rather by an exogenous cyclical pattern our third hypothesis test for the interaction between innovation, with total factor productivity as a proxy for innovation, and institutional quality's effect on GDP. We therefore estimate both if there needs to be interaction for institutions to influence GDP growth and in the same time what sort of institutions that best utilise long-term movements in innovation and TFP to enhance growth. Our new model estimates both the individual short- and long-term effects of institutions just as well as the two period effects for the interacting variable with TFP estimated as G7 average TFP annual growth.

$$GDP_{it} = \beta_1 GDP_{it-1} + \beta_2 Index^S_{it-1} + \beta_3 Index^L_{it-1} + \beta_4 TFP^S_{it-1} + \beta_5 TFP^L_{it-1} + \beta_6 Index^S_{it-1} * TFP^S_{it-1} + \beta_7 Index^L_{it-1} * TFP^L_{it-1} + \delta_{it} + \varepsilon_{it} \quad (6)$$

Adding an interaction term to a model alternate the interpretation of each estimated coefficient. If there were no interaction term, the individual index would be interpreted as the unique effect of institution on GDP. But the interaction means that the effect of institutional change on GDP is different for different values of TFP. The unique effect of institution on GDP is not limited to $\beta_2 - \beta_3$, but also depends on the values of $\beta_6 - \beta_7$ and TFP. As the new variables measuring interaction will be very small numbers and often take on negative means we can expect large coefficients (for full statistic characteristics of the interacting variables see Appendix F).

Table 7. Regression results H3 test

	Variable	H1 result	H3 result (lone variable)	H3 results (variable*TFP)
Long-term effects	Political risk, t-1	.1137003	-.0151932	31.14093**
		(.0803338)	(.0700913)	(15.34896)
	Economic risk, t-1	.0263755	.0988481	-25.29514**
		(.0816263)	(.0850948)	(11.8977)
	Freedom index, t-1	.2608746	.6327032***	-54.83527
		(.2614115)	(.2115555)	(45.35611)
	KOF Trade and capital, t-1	.0328362**	.0511934***	-3.280754
		(.0156003)	(.0195166)	(2.601088)
	KOF Political globalisation, t-1	.0623125	-.0663679	21.64229
		(.1079742)	(.0835502)	(16.94554)
	Education expenditures, t-1	.2304161**	.0920511	-5.490079
		(.1000686)	(.1372231)	(20.88243)
Short-term effects	Political risk, t-1	.0157567**	.0213639	-1.362015
		(.0079328)	(.0147354)	(1.691643)
	Economic risk, t-1	.0327835	.0271318	-4.985089
		(.0303745)	(.022576)	(4.110024)
	Freedom index, t-1	-.0491273	-.0071181	-28.09926
		(.0916621)	(.0949071)	(34.8407)
	KOF Trade and capital, t-1	-.0034199	.0022531	1.148095
		(.0049902)	(.0038675)	(.930382)
	KOF Political globalisation, t-1	-.0171349	-.0212367	3.484436
		(.0131681)	(.0150854)	(2.439927)
	Education expenditures, t-1	-.0474961	-.0395738*	6.300019
		(.0291353)	(.0241413)	(5.901892)
	Dependent variable, t-1	-.2035193***	-.1137132***	
		(.028353)	(.0372355)	
	Constant	.0224114***	.0140084**	
		(.0085288)	(.0063162)	
	AR (1)	0.0011	0.0183	
	AR (2)	0.0317	0.0601	
	Wald chi2	859.96 (13)	1356.46 (43)	
	Prob	0.000	0.0000	

*, ** and *** denote significant estimates at the 10, 5 and 1 % significance levels respectively

Standard errors are presented in parentheses below the parameter estimates

p-Values are presented for the AR-tests and the degrees of freedom for the Wald test are presented in parenthesis

Testing for interdependence reveal several interesting results as the model drops the TFP-variables due to collinearity. We no longer find any long-term effects of educational expenditures. Instead we find relationships between long-term change in both regulatory freedom and openness to trade (at the 1 % significant level). With our new variables measuring the interaction-relationship between TFP and the index we find significant results (at the 5 % significance level) for both political- and economic institutional quality. The coefficients show large number in line with expectations as the interaction variables show very small numbers compared to the dependent variable. Short-term coefficients indicate no relationship between the interacting index variable and GDP.

As our estimates significantly change based on the developed interacting model our third hypothesis is strengthened as there are evidence that there is a co-dependence required for long-term change in innovation and institutions to influence economic activity.

Hypothesis 4.

Long-term change is often found for developed countries (Berry, 1991: Berry, Kim and Kim, 1993; Schön, 2006) so it might very well be that our panel data, including both developed and developing countries, miss long-term effects as such is non-existing among developing countries. To test for this fourth hypothesis, we use our initial model (equation 4) and test for different sets of panel data, now sorted for the G7 countries, continent and a specific set of USA, Japan, Canada and Australia.

Table 8. Regression results H4 continental testing

	Variable	World (H1 results)	G7	Europe	USA, JPN, CAN & AUS	Asia	Africa	Middle east
Long-term effects	**Political risk, t-1**	.1137003	.1765627**	.1449988***	.0959381	.070699	-.0411832	.133356
		(.0803338)	(.0881624)	(.0453204)	(.0767371)	(.0952075)	(.0874089)	(.194129)
	Economic risk, t-1	.0263755	-.0415219	.098937**	-.0594619**	-.1489895**	.2036595	-.3113722
		(.0816263)	(.0296564)	(.0397336)	(.023939)	(.0646042)	(.1622922)	(.2220476)
	Freedom index, t-1	.2608746	1.063916***	-.0390737	1.495875***	.7956356**	-.0581725	1.373566***
		(.2614115)	(.324882)	(.0514445)	(.1884551)	(.3960763)	(.0766795)	(.5023814)
	KOF Trade and capital, t-1	.0328362**	-.0071469	.0358723	-.0014079	.0042818	.102287	-.5802881***
		(.0156003)	(.0783534)	(.0429351)	(.1039972)	(.0119031)	(.0969216)	(.1750489)
	KOF Political globalisation, t-1	.0623125	-.0067483	-.1112872***	.0106808	.2444406**	-.272485	2.30271***
		(.1079742)	(.0827396)	(.0323054)	(.1113697)	(.0955396)	(.1775625)	(.6925649)
	Education expenditures, t-1	.2304161**	.0773244*	.1500833	.0864811	-.192545***	.3105246***	.233945*
		(.1000686)	(.1464407)	(.1053283)	(.2265438)	(.0543679)	(.0957197)	(.124241)
Short-term effects	**Political risk, t-1**	.0157567**	-.0054951	.0058656	.0062495	.023686	.0442926*	-.1000149***
		(.0079328)	(.0199892)	(.0057646)	(.0160091)	(.0248979)	(.0257158)	(.016015)
	Economic risk, t-1	.0327835	-.0235211**	.0126487	-.0250701	.0030572	-.078727**	.1534637***
		(.0303745)	(.011607)	(.0095867)	(.0299083)	(.0164923)	(.0366456)	(.0423191)
	Freedom index, t-1	-.0491273	.2734756**	.0196257	.2346423	.20585	.0180409	-.7315452***
		(.0916621)	(.1150242)	(.0152289)	(.163021)	(.1322365)	(.0708713)	(.1613049)
	KOF Trade and capital, t-1	-.0034199	.0649401**	-.0045747	.0641213	-.0050914	.0531821	-.0354573***
		(.0049902)	(.0315041)	(.0045227)	(.048874)	(.0039015)	(.0375956)	(.01046)
	KOF Political globalisation, t-1	-.0171349	-.0188855	.0026072	-.0071659	.0092494	.0167197	.0329923
		(.0131681)	.0257021	(.0079417)	(.0285031)	(.0275456)	(.0222206)	(.0212847)
	Education expenditures, t-1	-.0474961	.0873904***	.0102207	.0544904	.0020002	-.0911312	-.1093948**
		(.0291353)	(.0211988)	(.0115028)	(.0371618)	(.0340637)	(.0800759)	(.0450351)
	Dependent variable, t-1	-.2035193***	.6065813***	.3087226**	.5923806***	.1628132**	-.0785898	-.1045713***
		(.028353)	(.0403473)	(.1276847)	(.1020782)	(.075019)	(.1100028)	(.0127354)
	Constant	.0224114***	.0011683	.0126087***	.0054324	.0349979***	.0367845***	.0099573
		(.0085288)	.0018095	(.0030497)	(.0044867)	(.0077086)	(.0075193)	(.0123208)
	AR (1)	0.0011	0.0351	0.0024	0.0509	0.0029	0.0109	0.0626
	AR (2)	0.0317	0.7301	0.3190	0.6875	0.1752	0.5998	0.9238
	Wald chi2	859.96 (13)	18.39	538.06	62.41	223.86	100.49	368.23
	Prob	0.000	0.0025	0.0000	0.0000	0.0000	0.0000	0.0000

*, ** and *** denote significant estimates at the 10, 5 and 1 % significance levels respectively

Standard errors are presented in parentheses below the parameter estimates

p-Values are presented for the AR-tests and the degrees of freedom for the Wald test are presented in parenthesis

Testing for continent specific effects reveal several interesting results. Both the G7 countries and Europe show significant (at the 5 % and 1 % significance level) results for political risk, a result not found for any other group. Europe seem to lose from political openness as this long-term coefficient show a negative result. On the other hand, long-term regulatory freedom show significant results for each group but Europe and Africa. No significant long-term results were found for Africa while institutional change has effect on the other continents growth. Results that make it hard to reject the hypothesis that long-term change primarily is a phenomenon affecting developed countries.

6. Analysis

After several tests, some results and deductions can be discussed. First, we look at our first hypothesis, that improved institutional quality cause long-term improvements in the economy. The few significant results that were found suggested that openness to trade and movement of capital have positive long-term effects on GDP. Our results indicate little further proof to confirm our hypothesis 1 that institutional reform cause long-term improvements in growth.

When testing hypothesis 2, whether long-changes in the economy cause growth enhancing institutional reform, even fewer evidence was found reinforcing the hypothesis. No significant results were found for long-term GDP growth or any index, making it hard to imply that long-term change in the economy influences institutional quality. The only variable showing significant results was short-term GDP and political institutions. Besides from this we do not find any significant relationship, meaning that the second hypothesis is rejected; long-term change in GDP does not seem to have a profound effect on institutional change. The result indicates that such a phenomenon is not universal and might only be found in country-specific examples (Berry, Elliott, Harpham and Kim, 1998). The lack of variables could result in an omitted variable bias, but this does not occur as our tests show few significant results.

Hypothesis 3 altered our results from the testing of hypothesis 1. Long-term effects of improved regulatory freedom were now found significant. Openness to trade remained a significant contributor to long-term change, as from our first regression. However, the interesting findings are the ones from the interacting coefficients between change in index and TFP. Both political and economic institutional reform, multiplied by TFP change, has significant (at the 5 % significance level) effects on long-term growth. In other words, growth-enhancing reforms of macroeconomic institutions coupled with improved institutional qualities on such as rule of law, transparent governing and reliable regulatory frameworks result in long-term improvements in GDP related to technological change and disruptive innovation. This gives strength to the argument that a stable and open business climate fosters growth as investments and entrepreneurs occurs without excessive regulatory restrictions and at low political risk (Berry, 1991; Schön, 2006; Bergh and Karlsson, 2010). The negative coefficient for long-term economic risk interacting with TFP growth could be explained by the fact that a large proportion of the panel data show negative coefficients, indicating that although a temporary decline in institutional quality of TFP-growth the long-term effect of the two is still positive. Such a relationship is reinforced by the fact that the short-term mean for the interacting economic risk variable show a negative average. The sole long-term index measuring openness to trade remains significantly positive and thus reinforcing previous research that trade has a positive effect on GDP (Lee Ha et al., 2004). Short-term coefficients indicate no relationship between the interacting model estimate and GDP. As our estimates significantly change based on the developed interacting model our third hypothesis is confirmed, as there is evidence of co-dependence required for long-term change in innovation and institutions to influence economic activity.

The tests of our fourth hypothesis, that long-term change and institutional reform is a causal relationship that only can be found within developed countries, discovered several noteworthy results. Only the G7 countries and Europe show significant results for political risk. This implies, from our third regression with the interacting variables, that such a relationship is truly dependent on a certain level of economic development. Long-term regulatory freedom shows significant results for each group but Europe and Africa. The estimate for the smallest group, consisting of the four countries, describe a negative relationship between economic risk and growth, perhaps can this be explained by the fact that both Japan and USA have been struggling with growth and debt levels for some time (Summers, 2016). Interestingly the results for the Middle east show just how dependent the continent is on foreign exports in commodities, finding long-term significant results for political and economic openness and regulatory freedom and short-term results for political and economic risk, regulatory freedom and openness to trade. Recent years volatility and instability can clearly be said to influence the continents ability to grow economically. No significant long-term results were found for Africa while institutional change has effect on the other continents' growth rates. These results confirm the hypothesis that long-term change primarily is a phenomenon affecting developed countries. This can be further analysed as the results suggest that reforms increasing regulatory freedom and increase of trade lose their growth enhancing impact on developed countries. Although Europe's result should be analysed bearing in mind that EU has strict restrictions on how much autonomy a country has in terms of economic openness. The results from testing for hypothesis 4 are not far from the results of Bergh and Karlsson (2010) who did not find either of the KOF Index of Globalisation to be important in explaining growth. It could also very well be explained by the fact that these indexes primarily measure the differences between open market-orientated and closed planned-economies, meaning that when comparing between relatively open economies the differences are too small.

Combining our results, a certain pattern seems to hold indicating that increased regulatory freedom combined with a stable political system is the best foundation for stable growth. This supports previous findings suggesting that economic freedom both have a direct effect on total factor productivity and an indirect effect on investment (Dawson, 1998). If the country is highly dependent on commodity exports, then developing openness to trade and stable economic and political institutions, just as regulatory freedom, is especially effective in creating long-term growth. For a developed country to not just enjoy average growth, but also reap the benefits from disruptive technological innovations there is a clear need for stable and efficient fiscal- and monetary policy combined with trustworthy and reliable political institutions.

Naturally there are risks pertaining to inaccurate results and erroneous misinterpretation of such. The short time-period of the dataset is a limitation, and thus a longer time series would add further strength to the analysis. A large proportion of the tests also runs the risk of a high degree of autocorrelation. The Arellano-Bond testing of autocorrelation also indicate presence of second order autocorrelation in several of our regressions. Such a scenario is to some extent almost certainly true as we estimate the total impact of a relatively few number of variables on the total economic activity. Therefore, it is just as complicated to construct a model including each and every variable affecting GDP without losing all likelihood of finding significant results. The other way could also very well be of relevance as the Wald Chi-square test indicate that we have overidentified the moment conditions. The region-specific results could indicate that our model is not correctly specified as we receive so various results – especially regarding Africa, a continent with more volatility among our variables which ought to increase the estimation. Discussions on exactly what variables to include in a GDP growth model could pose a draft for a time machine and this paper has based its modelling on previous literature (Fölster and Henrekson, 2001; Catrinescu, Leon-Ledesma, Piracha and Quillin, 2009; de Haan, Sturm and Zandberg, 2009; Bergh and Karlsson, 2010; Andersson, 2016).

If there is a desire to investigate specific institutional reforms and their effects on GDP further a recommendation would be to investigate for the respective sub-indexes and their effect on economic activity using the same modelling.

7. Conclusion

Since the birth of capitalism, long-term structural changes have affected society in numerous ways, and waves of disruptive innovation continue to challenge the way we live and produce (Berry, 1991). This paper has sought to find evidence that long-changes either affect or are affected by institutional quality. The conclusion is not singular nor absolute but after conducting several tests and by including variables affecting the degree of exposure to other countries' economies, the strongest evidence is that long-changes in the economy cause little institutional change. As western countries continue to debate the benefits and costs of openness and trade this paper find that a country with a higher degree of openness, especially when it comes to low tariffs and credit regulations, benefits from increased economic institutional quality. This connection, where openness improves economic institutional quality, which in turn positively affects GDP shows that although the advantages of openness might not always appear clearly, they are indeed present. Furthermore, this paper shows that high economic and political institutional quality, and openness to trade and capital nurture long-term innovation-driven growth. Or as Schumpeter might have put it: the best way to catch the wave would be through stable political and economic institutions and an open mind to free movement of both products and capital.

In summary, we find that institutional reforms have growth-enhancing effects on GDP. However, the appropriate reforms depend on whether long- or short-term growth is desired, whether a country seeks to benefit from long-term disruptive innovations, its level of development, and its level of dependency on natural resources. The causal relationship is found to be from institutional reform to long-term economic movement rather than the other way around.

Sources

Abramovitz, M. (1986) *Catching Up, Forging Ahead, and Falling Behind,* The Journal of Economic History, vol. 46, n. 2, p. 385-406

Acemoglu, D. and Robinson, J. (2012) *Why nations fail: The Origins of Power, Prosperity, and Poverty*, Crown Business, New York NY

Allison, P. D., Williams, R. and Moral-Benito, E. (2017) *Maximum Likelihood for Cross-lagged Panel Models with Fixed Effects,* Socius: Sociological Research for a Dynamic World, vol. 3, p. 1–17

Andersson, F. N. G. and Karpestam, P. (2012) *The Australian Carbon Tax - A Step in the Right Direction But Not Enough*, Future Science - Carbon Management, vol. 3 n. 3, p. 293-302

Andersson, F. N. G. (2015) *Reform Capacity and Macroeconomic Performance in the Nordic Countries*, Oxford University Press

Andersson, F. N. G. (2016) *A Blessing in Disguise? Banking Crises and Institutional Change*, World Development, vol. 83, p. 135–147

Andersson, F. N. G. (2017) *Sekulär stagnation – vad är det, finns det och hur påverkar det penningpolitiken?*, Ekonomisk Debatt vol. 45, n. 4, p. 13-25

Arellano, M. and Bond, S. (1991) *Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations*, Review of Economic Studies, vol. 58, p. 277–297

Arellano, M. and Bover, O. (1995) *Another look at the instrumental variable estimation of error-components models*, Journal of Econometrics vol. 68, p. 29–51

Baltagi, B. H. (2013) *Econometric Analysis of Panel Data*, 5th ed. Chichester, UK: Wiley

Berry, B. J. L. (1991) *Long-wave rhythms in economic development and political behaviour*, Johns Hopkins University Press

Berry, B. J. L., Kim, H. and Kim, M. (1993) *Are long waves driven by techno-economic transformations?: Evidence for the U.S. and the U.K.*, Technological Forecasting and Social Change, vol. 44, n. 2

Berry, B. J. L., Elliott, E. W., Harpham E. J. and Kim, H. (1998) *The Rhythms of American Politics*, Lanham, MD: University Press of America.

Bergh, A. and Karlsson, M. (2010) *Government size and growth: Accounting for economic freedom and globalization*, Public Choice, vol.142, p.195–213

Blundell, R. and Bond, S. (1998) *Initial conditions and moment restrictions in dynamic panel data models*, Journal of Econometrics vol. 87, p. 115–143

Bresnahan, T. F. and Trajtenberg, M. (1995) *General Purpose Technologies. Engines of Growth?* Journal of Econometrics, vol. 65, p. 83-108

Bund, M. J. G. and Windmeijer, F. (2010) *The weak instrument problem of the system GMM estimator in dynamic panel data models,* Econometrics Journal, vol. 13, p. 95–126.

Cowen, T. (2011) *The Great Stagnation*, Dutton Books, New York

Catrinescu, N., Leon-Ledesma, M., Piracha, M. and Quillin, B. (2009) R*emittances, institutions, and economic growth*, World Development, vol. 37, p. 81-92

Cavallo, A. F. and Cavallo, E. A. (2010) *Are crises good for long term economic growth? The role of political institutions,* Journal of Macroeconomics, vol. 32, p. 838–857

Choi, I. (2001) *Unit root tests for panel data*, Journal of International Money and Finance, vol. 20, p. 249–272

Claessens, S., Klingebiel, D., and Laeven, L. (2002) *Financial restructuring in banking and corporate sector crises: Which policies to pursue?* in D. Klingebiel, & L. Laeven (Eds.), *Managing the real and fiscal effects of banking crises*, World bank discussion paper 428

Dawson, J. W. (1998) *Institutions, investment, and growth: New cross-country and panel data evidence,* Economic Inquiry, vol. 36, p. 603–619

Devezas, T. C., Linstone, H. A. and Santos, H. J. S. (2005) *The Growth Dynamics of the Internet and the Long Wave Theory,* Technological Forecast & Social Change vol. 72, p. 913-935

Dixit, A. (2009) *Governance Institutions and Economic Activity,* American Economic Review 2009, vol. 99, p. 5–24

Dornbusch, R. and Edwards, S. (1990) *The Macroeconomics of Populism in Latin America*, University of Chicago Press

Dreher, A. (2006) *Does globalization affect growth? Empirical evidence from a new index,* Applied Economics, vol. 38, p. 1091–1110

European Environmental Agency (2011) *Environmental Tax Reform in Europe: Opportunities for Eco-innovation*, EEA Technical Report n. 17

Feenstra, R. C. (2004) *Advanced International Trade: Theory and Evidence*, Princeton: Princeton University Press, p. 31–63

Florida, R. (2002) *The rise of the creative class*, New York: Basic Books

Fölster, S. and Henrekson, M. (2001) *Growth effects of government expenditure and taxation in rich countries*, European Economic Review, vol. 45, p. 1501–1520

Glaeser, D. L., La Pota, R., Lopez-de-Silanes, F. and Shleifer, A. (2004) *Do institutions cause growth?*, Journal of Economic growth, vol. 9, p. 271–303

Grübler, A. and Nakicenovic, N. (1991) *Long Waves, Technology, Diffusion, and Substitution*, Research Report. International Institute for Applied Systems Analysis, Laxenburg, Austria

Hall, P. and Preston, P. (1988) *The Carrier wave: New Information-Technology and the Geography of Information 1846-2003*, London: Unwin and Hyman de Haan, J., Sturm, J.-E. and Zandberg, E. (2009) *The impact of financial and economic crises on economic reform,* In J. Gwartney, & R. Lawson (Eds.), Economic freedom of the world 2009 annual report, Economic Freedom Network

Hamilton, J. D. (2017) *Why you should never use the Hodrick-Prescott filter,* working paper, Department of Economics, UC San Diego

Internet society, 1997, *Brief history of the internet*, [Subtracted 14/11 2017, available online: https://www.internetsociety.org/internet/history-internet/brief-history-internet/]

Jeffe, A. B. and Palmer, K. (1997) *Environmental Regulation and Innovation: a Panel Data Study*, The Review of Economics and Statistics vol. 79, p. 610-619

Jovanovic, B. and Rousseau, P.L. (2006) *General Purpose Technologies.* In Aghion P., Durlauf S.N. Handbook of Economic Growth, North-Holland, Amsterdam, Netherlands

Kaminsky, G. L., and Reinhart, C. M. (1999) *The twin crises: The cause of banking and balance-of-payments problems*, American Economic Review, vol. 89, p. 473–500

Knight, M., Loayza, N. and Villanueva, D. (1993) *Testing the Neoclassical Theory of Economic Growth: A Panel Data Approach,* Staff Papers (International Monetary Fund) vol. 40, n. 3, p. 512-541

Lanjouw, J. O. and Mody, A. (1996) *Innovation and the International Diffusion of Environmentally Responsive Technology*, Research Policy vol. 25, p. 549-571

Lee Ha, Y., Ricci Luca, A. and Rigobon, R. (2004) *Once again, is openness good for growth?* Journal of Development Economics, vol. 75, p. 451–472

Linstone, H.A. and Mitroff, I.I. (1994) *The Challenge of the 21st Century,* State University of New York Press, Albany, NY

Lipsey, R. G. (2009) *Economic Growth Related to Mutually Interdependent Institutions and Technology*, Journal of Institutional Economics vol. 5, n. 3, p. 259-288

Liu, S. (2011) *Characteristics of Chinese economic cycles: A wavelet analysis of Chinese GDP series,* International Conference on Information Science and Technology Information Science and Technology (ICIST), 2011 International Conference, p. 556-559

Marshall, A. (1892) *Principles of Economics,* London

Mensch, G. (1979) *Stalemate in Technology: Innovations Overcome the Depression*, Ballinger, Cambridge, MA

Mensch, G. (2006) *If this Long Wave Steeps-Up and Breaks: What then?* Kondratieff waves, Warfare and World Security, vol. 5, n. 1, p. 80-90

Metz, R. (2005) *Empirical Evidence and Causation of Kondratieff Cycles*, Presented at the NATO Advanced Research Workshop on Kondratieff Waves, Warfare and World Security, February 14–18, 2005, Covilhã, Portugal

Mokyr, J. (1994) *The Lever of Riches – Technological Creativity and Economic Progress*, Oxford University Press

OECD (2003) *ICT and Economic growth, Evidence from OECD Countries, Industries and Firms,* Paris: OECD

Perez, C. (1983) *Structural change and assimilation of new technologies in the economic and social systems,* Futures 1983 October, n. 362

Perez C. (2007) *Respecialisation and the Deployment of the ICT Paradigm*. In Compano R, Pascu C, Bianchi A, Burgelman J-C, Barrios S, Ulbrich M, Maghiros I. *The Future of the Information Society in Europe: Contributions to Debate*. Technical report UR22353EN, IPTS, Joint Research Centre, Directorate General, European Commission

Piatier, A. (1981) *Innovation, Information and Long-term Growth*, Futures, p. 371-382

Shackleton, R. (2013) *Total Factor Productivity Growth in Historical Perspective,* Working Paper Series Congressional Budget Office Washington, D.C., n. 1

Schwartz, A. J. (2009) *Origins of the Financial Market Crisis of 2008*, Cato Journal, vol. 29, n. 1

Schön, L. (2006) *Tankar om cycler,* Studieförbundet Näringsliv och samhälle

Schön, L. (2008) *Technological Shifts and Convergence in a European Perspective since 1950,* Scandinavian Economic History Review vol. 55, p. 222-243

Solow, R. M. (1956) *A Contribution to the Theory of Economic Growth*, The Quarterly Journal of Economics, vol. 70, p. 65–94

Summers, L. H. (2016) *The Age of Secular Stagnation: What It Is and What to Do About It*, Foreign Affairs vol. 2

Tunzelmann von, N. (2003) *Historical Coevolution of Governance and Technology in the Industrial Revolutions*, Structural Change and Economic Dynamics, vol. 14, p. 365-384

Windmeijer, F. (2005) *A finite sample correction for the variance of linear efficient two-step GMM estimators*, Journal of Econometrics vol. 126, p. 25–51

APPENDIX

APPENDIX A - Data

Penn World Tables

GDP is estimated as real GDP at constant 2011 national prices in million 2011 US dollars.
TFP is measured at constant national prices (index 2011=1).
[Subtracted 5/12 2017, available online: https://www.rug.nl/ggdc/productivity/pwt/]

KOF Globalisation index

The KOF Globalisation Index measures the three main dimensions of globalisation: economic, social and political. Data are available on a yearly basis for 207 countries over the period 1970 - 2014.
[Subtracted 3/12 2017, available online: http://globalization.kof.ethz.ch/]

ICRG dataset on political, financial and economic risk

The International Country Risk Guide (ICRG) rating comprises 22 variables in three subcategories of risk: political, financial, and economic. A separate index is created for each of the subcategories.

Fraser institute – Economic freedom index

The index published in *Economic Freedom of the World* measures the degree to which the policies and institutions of countries are supportive of economic freedom.
[Subtracted 3/12 2017, available online: https://www.fraserinstitute.org/studies/economic-freedom]

Maddison - World GDP and population year 1-2008AD

Has been used due to the research and data collected by Angus Maddison, university of Groningen. [Subtracted 24/10 2017, available online: http://www.ggdc.net/maddison/oriindex.htm]

Bank of England

Consumer Price Inflation in the United Kingdom, retrieved from FRED, Federal Reserve Bank of St. Louis, [Subtracted 1/11 2017, available online: https://fred.stlouisfed.org/series/CPIIUKA]

Total Factor Productivity Growth in the United Kingdom, retrieved from FRED, Federal Reserve Bank of St. Louis, [Subtracted 1/11 2017, available online: https://fred.stlouisfed.org/series/TFPGUKA]

Real Gross Domestic Product at Market Prices in the United Kingdom, retrieved from FRED, Federal Reserve Bank of St. Louis, [Subtracted 2/11 2017, available online: https://fred.stlouisfed.org/series/RGDPMPUKA]

World Bank

World Bank national accounts data, and OECD National Accounts data files, [Subtracted 5/11 2017, available online: https://data.worldbank.org/indicator/NY.GDP.PCAP.CD]

EU KLEMS Growth and Productivity Accounts

[Subtracted 29/12 2017, available online: http://www.euklems.net]

APPENDIX B - Country list

Argentina

Australia

Austria

Bahrain

Belgium

Bolivia (Plurinational State of)

Botswana

Brazil

Bulgaria

Burkina Faso

Cameroon

Canada

Chile

China

China, Hong Kong SAR

Colombia

Costa Rica

Cyprus

Côte d'Ivoire

Denmark

Dominican Republic

Ecuador

Egypt

Finland

France

Gabon

Germany

Greece

Guatemala

Honduras

Hungary

Iceland

India

Indonesia

Iran (Islamic Republic of)

Iraq

Ireland

Israel

Italy

Jamaica

Japan

Jordan

Kenya

Kuwait

Luxembourg

Malaysia

Malta

Mexico

Mongolia

Morocco

Mozambique

Netherlands

New Zealand

Nicaragua

Nigeria

Norway

Panama

Paraguay

Peru

Philippines

Poland

Portugal

Qatar

Republic of Korea

Romania

Saudi Arabia

Senegal

Sierra Leone

Singapore

South Africa

Spain

Sri Lanka

Sudan (Former)

Sweden

Switzerland

Taiwan

Thailand

Togo

Trinidad and Tobago

Tunisia

Turkey

U.R. of Tanzania: Mainland

United Kingdom

United States

Uruguay

Venezuela (Bolivarian Republic of)

Zimbabwe

APPENDIX C –Heteroscedasticity test result

Modified Wald test for groupwise heteroscedasticity in fixed effect regression model

H0: sigma(i)^2 = sigma^2 for all i

chi2 (87) = 2.2e+05

Prob>chi2 = 0.0000

APPENDIX D - Unit root test results

	GDP				TFP			
	Augmented Dickey-Fuller		***Phillips-Perron***		***Augmented Dickey-Fuller***		***Phillips-Perron***	
	Statistic	*p-value*	*Statistic*	*p-value*	*Statistic*	*p-value*	*Statistic*	*p-value*
Inverse chi-squared	780.1367	0.0000	1301.6042	0.0000	12.2263	1.0000	10.6207	1.0000
Inverse normal	-19.4868	0.0000	-27.8019	0.0000	13.9161	1.0000	14.5639	1.0000
Inverse logit	-22.6620	0.0000	-38.3302	0.0000	13.4893	1.0000	14.2381	1.0000
Modified inv. chi-squared	32.4923	0.0000	60.4459	0.0000	-8.6720	1.0000	-8.7580	1.0000

	Political risk				Economic risk			
	Augmented Dickey-Fuller		***Phillips-Perron***		***Augmented Dickey-Fuller***		***Phillips-Perron***	
	Statistic	*p-value*	*Statistic*	*p-value*	*Statistic*	*p-value*	*Statistic*	*p-value*
Inverse chi-squared	972.8349	0.0000	3599.1274	0.0000	235.4531	0.0013	626.9596	0.0000
Inverse normal	-22.2758	0.0000	-52.4314	0.0000	-1.6398	0.0505	-12.1908	0.0000
Inverse logit	-27.3546	0.0000	-107.0146	0.0000	-1.9746	0.0245	-15.6386	0.0000
Modified inv. chi-squared	42.8220	0.0000	183.6061	0.0000	3.2942	0.0005	24.2812	0.0000

	Freedom index				Education expenditures			
	Augmented Dickey-Fuller		***Phillips-Perron***		***Augmented Dickey-Fuller***		***Phillips-Perron***	
	Statistic	*p-value*	*Statistic*	*p-value*	*Statistic*	*p-value*	*Statistic*	*p-value*
Inverse chi-squared	21.8522	1.0000	329.5264	0.0000	97.1119	1.0000	347.2229	0.0000
Inverse normal	14.7864	1.0000	2.7224	0.9968	7.0406	1.0000	-2.5555	0.0053
Inverse logit	15.4930	1.0000	0.1868	0.5740	7.0904	1.0000	-4.5724	0.0000
Modified inv. chi-squared	-7.9730	1.0000	8.8120	0.0000	-3.8673	0.9999	9.7774	0.0000

	KOF political globalisation				KOF trade and credit index			
	Augmented Dickey-Fuller		***Phillips-Perron***		***Augmented Dickey-Fuller***		***Phillips-Perron***	
	Statistic	*p-value*	*Statistic*	*p-value*	*Statistic*	*p-value*	*Statistic*	*p-value*
Inverse chi-squared	126.4742	0.9948	548.0212	0.0000	199.3574	0.0395	1439.1392	0.0000
Inverse normal	4.3503	1.0000	-9.3990	0.0000	-0.0822	0.4672	-25.3639	0.0000
Inverse logit	4.1748	1.0000	-12.1429	0.0000	-0.1273	0.4494	-41.0796	0.0000
Modified inv. chi-squared	-2.3605	0.9909	20.5011	0.0000	1.8307	0.0336	69.8726	0.0000

APPENDIX E - Pairwise Granger Causality Tests

Null Hypothesis:	Obs	F-Statistic	Prob.
TFP_G7_L does not Granger Cause DGDP	1827	1.20797	0.2719
DGDP does not Granger Cause TFP_G7_L*		3.40467	0.0652
POLRISK_L does not Granger Cause DGDP	1936	1.51058	0.2192
DGDP does not Granger Cause POLRISK_L		0.22561	0.6349
ECRISK_L does not Granger Cause DGDP	1408	0.30193	0.5828
DGDP does not Granger Cause ECRISK_L		2.41842	0.1201
KOFTCR_L does not Granger Cause DGDP*	1566	2.71723	0.0995
DGDP does not Granger Cause KOFTCR_L		0.12366	0.7251
KOFPG_L does not Granger Cause DGDP*	1598	2.79920	0.0945
DGDP does not Granger Cause KOFPG_L		0.73234	0.3923
EDUEXP_L does not Granger Cause DGDP**	1359	4.49809	0.0341
DGDP does not Granger Cause EDUEXP_L		0.49404	0.4822
FREEX_L does not Granger Cause DGDP***	1700	25.4998	5.E-07
DGDP does not Granger Cause FREEX_L		0.73467	0.3915
POLRISK_L does not Granger Cause TFP_G7_L***	1762	8.89342	0.0029
TFP_G7_L does not Granger Cause POLRISK_L***		88.6269	1.E-20
ECRISK_L does not Granger Cause TFP_G7_L***	1408	22.4970	2.E-06
TFP_G7_L does not Granger Cause ECRISK_L***		81.9168	5.E-19
KOFTCR_L does not Granger Cause TFP_G7_L	1566	0.10420	0.7469
TFP_G7_L does not Granger Cause KOFTCR_L***		56.3169	1.E-13
KOFPG_L does not Granger Cause TFP_G7_L***	1598	8.33749	0.0039
TFP_G7_L does not Granger Cause KOFPG_L***		44.8166	3.E-11
EDUEXP_L does not Granger Cause TFP_G7_L**	1359	5.53229	0.0188
TFP_G7_L does not Granger Cause EDUEXP_L***		29.4688	7.E-08

Null Hypothesis:	Obs	F-Statistic	Prob.
KOFTCR_L does not Granger Cause POLRISK_L	1501	1.23225	0.2671
POLRISK_L does not Granger Cause KOFTCR_L***		10.2245	0.0014
KOFPG_L does not Granger Cause POLRISK_L**	1533	5.59033	0.0182
POLRISK_L does not Granger Cause KOFPG_L		0.54225	0.4616
EDUEXP_L does not Granger Cause POLRISK_L	1316	0.13834	0.7100
POLRISK_L does not Granger Cause EDUEXP_L**		5.26013	0.0220
FREEX_L does not Granger Cause POLRISK_L***	1636	7.58600	0.0059
POLRISK_L does not Granger Cause FREEX_L		1.22328	0.2689
KOFTCR_L does not Granger Cause ECRISK_L	1335	0.05358	0.8170
ECRISK_L does not Granger Cause KOFTCR_L		1.69733	0.1929
KOFPG_L does not Granger Cause ECRISK_L***	1363	8.55048	0.0035
ECRISK_L does not Granger Cause KOFPG_L***		7.97146	0.0048
EDUEXP_L does not Granger Cause ECRISK_L	1034	1.27922	0.2583
ECRISK_L does not Granger Cause EDUEXP_L		2.68050	0.1019
FREEX_L does not Granger Cause ECRISK_L***	1248	23.6293	1.E-06
ECRISK_L does not Granger Cause FREEX_L		0.31318	0.5758
KOFPG_L does not Granger Cause KOFTCR_L***	1566	19.5523	1.E-05
KOFTCR_L does not Granger Cause KOFPG_L		0.70137	0.4025
EDUEXP_L does not Granger Cause KOFTCR_L	1148	0.39961	0.5274
KOFTCR_L does not Granger Cause EDUEXP_L		0.77707	0.3782
FREEX_L does not Granger Cause KOFTCR_L	1409	2.03173	0.1543
KOFTCR_L does not Granger Cause FREEX_L		0.30022	0.5838
EDUEXP_L does not Granger Cause KOFPG_L	1177	0.14249	0.7059
KOFPG_L does not Granger Cause EDUEXP_L		2.42271	0.1199

FREEX_L does not Granger Cause TFP_G7_L***	1618	17.0359	4.E-05
TFP_G7_L does not Granger Cause FREEX_L***		9.72243	0.0019
ECRISK_L does not Granger Cause POLRISK_L*	1408	3.75559	0.0528
POLRISK_L does not Granger Cause ECRISK_L		0.00134	0.9708

FREEX_L does not Granger Cause KOFPG_L**	1441	5.77643	0.0164
KOFPG_L does not Granger Cause FREEX_L***		14.1407	0.0002
FREEX_L does not Granger Cause EDUEXP_L**	1258	6.63571	0.0101
EDUEXP_L does not Granger Cause FREEX_L		0.05519	0.8143

*, ** and *** denote significant estimates at the 10, 5 and 1 % significance levels respectively

APPENDIX F – Descriptive statistics TFP-interacting variable

Variable	Mean	Standard deviation (actual and share of mean)	Observations	
PolTFP_L	0,007%	0,020%	N=	1891
		286%	n=	87
			T=	21,7356
PolTFP_S	-0,011%	0,096%	N=	1891
		-874%	n=	87
			T=	21,7356
EcTFP_L	0,011%	0,032%	N=	1663
		284%	n=	87
			T=	19,1149
EcTFP_S	-0,028%	0,142%	N=	1663
		-508%	n=	87
			T=	19,1149
FrTFP_L	0,008%	0,020%	N=	1747
		243%	n=	83
			T=	21,0482
FrTFP_S	0,002%	0,024%	N=	1725
		1178%	n=	82
			T=	21,0366
EdTFP_L	0,005%	0,025%	N=	1536
		481%	n=	83
			T=	18,506
EdTFP_S	-0,013%	0,117%	N=	1537
		-895%	n=	83
			T=	18,5181
KCTFP_L	0,015%	0,058%	N=	1755
		389%	n=	83
			T=	21,1446
KCTFP_S	-0,034%	0,173%	N=	1755
		-513%	n=	83
			T=	21,1446
KPTFP_L	0,005%	0,023%	N=	1799
		455%	n=	85
			T=	21,1647
KPTFP_S	-0,022%	0,105%	N=	1799
		-482%	n=	85
			T=	21,1647