Escaping the Middle-Income Trap by Moving Up the Technology Ladder? An Empirical Investigation

Erasmus Universiteit Rotterdam

Master Thesis
Jelle van den Berg
Erasmus School of Economics

Supervisor: Dr. E.O. Pelkmans-Balaoing
Date: 04-08-2013

Table of Contents

Abstract

The middle-income trap is the phenomenon of middle-income countries failing to graduate into the ranks of high-income nations after previous rapid growth. Their stagnation can be explained by a competitive squeeze between low-wage producers on one side, and highly skilled, fast-moving innovators on the other. Accordingly, it is proposed that moving up the technology ladder, mastering innovation and increasing value added can regain competiveness and thereby offer a way out.

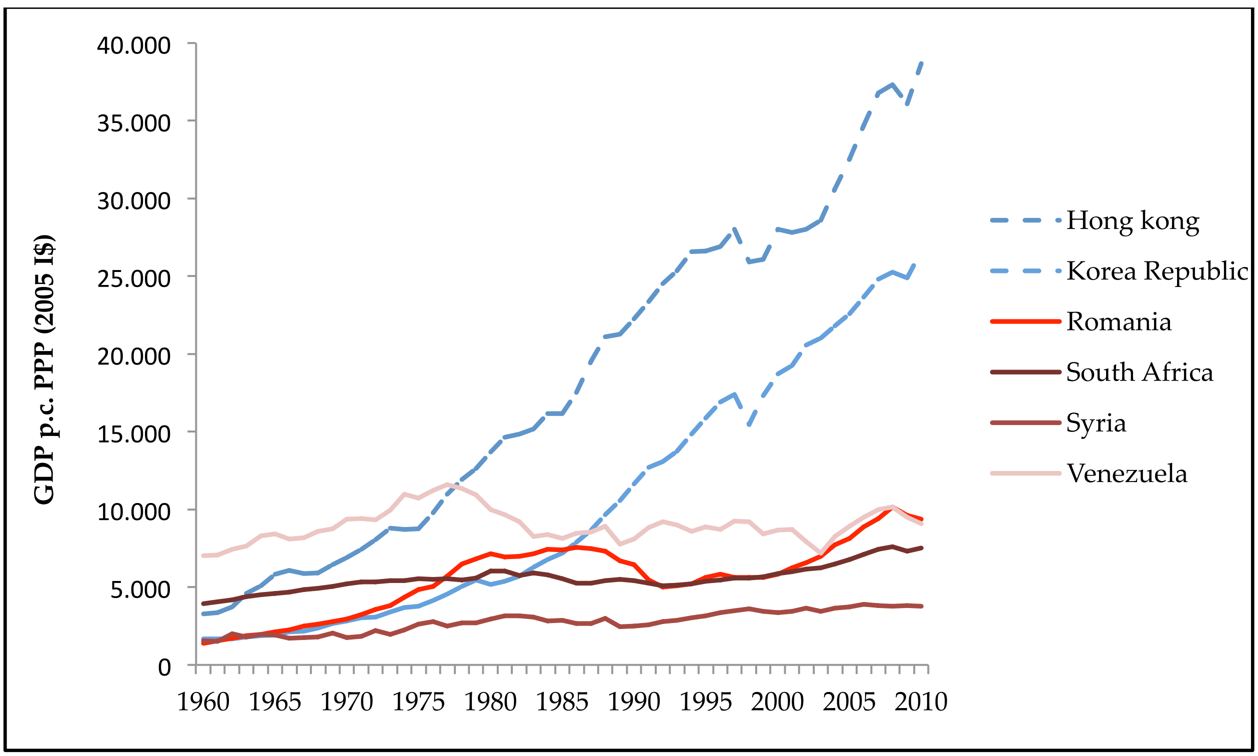
This paper is interested in the robustness and validity of this claim. Therefore an empirical investigation of the relationship between economic upgrading and middle-income growth rates is presented. More specifically, can increasing export complexity indeed serve as a way to escape or avoid the middle-income trap? Using a panel of current and former middle-income countries and trade data induced proxies for export complexity it is found that upgrading of the export basket does not significantly predict middle-income growth. The results hold for several robustness checks including segmenting the dataset in different subgroups.

Noted however should be that due to global value chains and fragmented production, measuring actual value added from trade data is found to be very challenging. Insights stemming from alternatives measures of complexity, perhaps better able to capture value-added, are therefore welcome contributions.

1. Introduction

Resulting from last decades' fortunate development achievements, numerous countries have been able to escape poverty and reach middle-income status. Logically, growth was envisioned to endure and joining the club of high-income countries was next on the agenda. So far however, for most countries the happy principle of (conditional) convergence does not hold. Numerous examples: Romania, South Africa, Syria and Venezuela to name a few, reached middle-income status a substantial time ago but have failed to become a high-income country since. This lot of countries that reduced poverty, made impressive progress but subsequently became subject to stagnation or economic decline are increasingly portrayed as victims of the middle-income trap; a term introduced by Gill and Kharas (2007).

Figure 1: Few countries escape the middle-income trap



Source: Penn World Tables 7.1 and author's calculations.

In short, the middle-income trap can be considered a competiveness problem. Entrapped countries are unable to compete with innovative high-income nations that govern fast paced-high technology industries on the one hand. But lost cost advantages against low wage countries in mature and standardized industries on the other. Hence, they are squeezed in the middle. Although easier said than done, it is therefore argued that confronting the middle-income trap requires shifting the structure of production and exports towards activities of greater value added and technology advancement (Eichengreen et al., 2013; Kharas and Kohli, 2011; Yusuf and Nabeshima, 2009; for example). Of interest for both policymakers and researchers than becomes the validity of this claim. Namely only via sound theories and the correct tools for analyses can government action maximize its full potential and be effective in the areas where intended.

Therefore, this paper hopes to add to the debate by empirically investigating whether exporting products containing more skill and technology, or differently put, increasing export complexity, indeed can spur middle-income growth rates and thereby offer a way out of the middle-income trap. This is important for a number of reasons. Firstly, over 70% of the world's population resides in middle-income countries. Secondly, middle-income transitions are the future for low-income countries, making a thorough understanding of this development phase apparent. Also, lower-cost developing countries need room at the labour intensive - low technology spectrum of the world economy. Middle-income countries thus need to move up in order for their poorer counterparts to develop. Moreover, significant slowdowns in China and India will have a major effect in the world economy and hence avoiding their stagnation will be very beneficial. Lastly, prolonged periods of weak progress may potentially endanger countries' political and social stability, with the Arabic Spring as a prime example.

Empirical evidence for the existence of a middle-income trap recently has been presented by Eichengreen, Park and Shin (2012, 2013) and Aiyar et al. (2013). Next to presenting evidence for the existence of a trap, these papers aim to advance the understanding on middle-income growth slowdowns. Their results accordingly point in favour of high technology and more diversified exports next to a skilful population to avoid the middle-income trap. In a similar vein, Hausmann, Hwang and Rodrik (2007) and Hidalgo and Hausmann (2009) show that the complexity of a country's export basket can be important for future growth. Their claims are based on trade data induced indexes of export complexity, namely EXPY and the Economic Complexity Index (ECI). Not by coincidence, these two measures, together with Economic Fitness as proposed by Tachella et al. (2012), will form the methodological base of this paper.

Measures of economic complexity potentially provide objective measures that can be valuable within governments and development agencies for strategic decision-making. Especially with the recent surge in worry and interest for the middle-income trap, empirical validation of the theory is welcomed. A wide panel of current and former middle-income countries therefore serves to evaluate the contribution of EXPY, ECI and Fitness on middle-income growth rates. At first sight these proxies for export complexity seems to have significant predictive power. However, after the inclusion of suitable controls and usage of more appropriate econometric techniques EXPY, ECI and Fitness are found improper instruments to predict middle-income growth rates. The results holds after segmenting the dataset in several subgroups, including lower middle-income countries, upper middle-income countries and countries that did or do not show any signs of being trapped.

This paper continues with an introduction and description of the middle-income trap. Next, previous empirical works on middle-income growth slowdowns are discussed. Chapter four and five then elaborate on how to classify countries as middle-income and the used proxies for export complexity. Thereafter, section six presents several trends concerning export complexity that emerge from the data while chapter seven describes the data and chosen methodology. This is followed by the growth regressions in section eight. Lastly, chapter nine summarizes and concludes.

2. The Middle-Income Trap

After the crucial first step of shaking off poverty and becoming a middle-income country, acquiring high-income status is the anticipated and desired next goal. As discussed however, the latter proves to be so challenging that several economies have long failed to transition to high-income levels and are therefore understood to be in the middle-income trap. The World Bank (2012: P.12) for example estimates that from over a 100 countries classified as middle-income in 1960, only 13[1] managed to advance to high-income by 2008. This chapter describes the reasons why countries get caught in the middle-income trap, reviews the proposed solutions to get back on an upward growth trajectory and addresses the role played by high technology (complex) exports. It is instructive however to start the discussion at the early stages of development.

2.1 – Early stages of Development

At low levels of per capita income, countries traditionally develop once investment and labour shifts from farming and other primary activities to manufacturing and services.

---

[1] These countries are Equatorial Guinea, Greece, Hong Kong SAR, China, Ireland, Israel, Japan, Mauritius, Portugal, Puerto Rico, Korea, Dem Rep., Singapore, Spain, and Taiwan, China.

During this cross-sector migration from rural to urban areas and activities, knowhow and technologies can be imported from abroad and utilized by the newly available manufacturing workforce. Productivity is assumed to increase while wages remain low due to a large, or "unlimited" if one follows Lewis (1954), reserve army of labour. Local firms initial focus typically is on "learning how to adapt foreign technology to the domestic context through imitation, reverse engineering, learning by doing and learning by using" (Paus, 2012: P.123). The mix of new skill and technology, low labour costs and the high income-elasticity of demand for manufactures allow businesses to be globally competitive. Increased productivity and exports accordingly spur growth rates and countries enter the middle-income phase of development.

After this initial phase of economic restructuring, the factors and advantages that generated high growth rates disappear and the possibility to get trapped emerges. The supply of surplus labour namely is not inexhaustible and eventually a tightening labour market will cause wages to increase. This positive development however undermines "the 'low cost' model of development" (Yusuf and Nabeshima, 2009: P.2). Hence, declining cost advantages make competing in the global market of lower-wage, labour-intensive (manufacturing) goods problematic. The sectors that once drove growth generally move to lower-wage countries and the economy needs to shift to products or industries with increased value added or more innovative by nature; alternatively described by Spence (2011: P.100) as: "more capital-, human capital-, and knowledge-intensive in the way they create value". In other words, increased catching up surges the importance of competitiveness and innovation. Additionally, with the economy approaching the technological frontier, innovation and development progressively needs to be endogenous.

In summary, the mechanization of agriculture, labour transfers and absorption of foreign knowledge typically allowed advancement to middle-income stages of development. Production costs however eventually increase, mainly when the pool of underemployed labour empties, and competiveness erodes. Physical capital investments become of lesser importance and continuing growth requires new sources of competiveness. Intuitively, these can be found in innovation, technological upgrading and greater value adding activities.

2.2 – Squeezed In the Middle

The bottleneck for many middle-income countries however is a difficulty to master complex technologies, produce native innovations and broadly upgrade the economy. The above discussion is for example formalised in the 2010 World Bank East Asia and Pacific Economic Update (P.27) by defining the middle-income trap as a situation where "countries are struggling to remain competitive as high-volume, low-cost producers in the face of rising wage costs, but are yet unable to move up the value chain and break into fast-growing markets for knowledge and innovation-based products and services". Following closely the original contribution of Gill and Kharas (2007: P.5) that entrapped countries "are squeezed between the low-wage poor-country competitors that dominate in mature industries and the rich-country innovators that dominate in industries undergoing rapid technological change." Hence, the general consensus that declining cost advantages constrain development unless broad competitiveness in technology-intensive activities higher up the value chain replaces the export sectors initially important for growth.

The struggle experienced by many middle-income countries to become a competitive high-skill innovator and exporter partly roots in an unfavourable business climate with as its main pillars uncertainty and insufficient initial levels of skill and technology.

Insecurity about future returns and reaping the full benefits of innovation creates and entrepreneurship problem resulting in under-investments in the discovery process of new goods, services or markets. Hausmann and Rodrik (2003) addresses this issue from the information externalities that come with the process of "cost discovery". Success of first entrants namely provides valuable information to other entrepreneurs who can now quickly enter the new activity. The pioneering entrepreneur however does not get compensated for the initial effort, while the costs of possible failure are all borne privately. Additionally, efforts to innovate production processes and increase value added are curbed by excessive development costs, large technology gabs or simply missing the required skill or knowledge[2]. In order to address the middle-income trap, governments are therefore ought to support the accumulation and upgrading of human capital, science and technology and put in place an economic environment prone to risk-taking and counteracting factors that hinder innovation. The World Bank (2010: P27) for example identifies "high levels of investment which embody new technologies" and an "enabling environment for creative destruction" as key and overarching requirements to move into the high-income group.

2.3 – Enabling Conditions

The domestic capability to upgrade and innovate however is contingent on what the literature often labels "complementary inputs", "enabling conditions" or "indispensable institutions". At the minimum, stable macroeconomics and functional fiscal and monetary policies are required. Other usual suspects refer to: good-quality (ICT) infrastructure, protection of property rights, a sound financial system, control of corruption, appropriate access to investment capital, good urban management and

[2] "The 'skills crisis' is a well-known shortcoming of the Malaysian economy. The response 'not enough good people' is a common complaint among business owners in Malaysia" (Flaaen et al., 2013: P.23)

effective rule of law (Cai, 2011; Paus, 2012; Agénor and Canuto, 2012; among others). However, especially agreed upon is the need for higher levels of investment in schooling and training and a re-tuning of the education system. The importance assigned to education stems from the fact that a countries' capability to move up the technology ladder largely depends on the quality of its labour force. Or in other words "Education and other forms of human capital development clearly provide a fundamental underpinning for domestic innovation activity and the absorptive (learning) capacity of the economy" (Gill and Kharas, 2007: P.175). A good example showing the importance of upgrading towards a knowledge economy can be found in the impressive experience of the Asian Tigers. After making technology and higher education distinctive core elements of their development approach, these countries namely were able move up the value chain and become competitive as a high-skill innovator.

Government focus should thus be on providing and possibly maintaining a good base. Important during this process is consensus building among all government and private stakeholders (Ohno, 2011). Granting a private-public endeavour to regain global competiveness, Rodrik (2004: P.38) recommends "an interactive process of strategic cooperation between the private and public sectors" which serves to identify business opportunities and constraints and generate appropriate policy initiatives in response. While Paus (2012: P.126) stresses the importance of an "interactive co-evolution of social and firm capabilities"; since the absence of key institutions or complementary inputs will slow or even block the upgrading process and causes countries to get stuck. Finally, based on the Capabilities Theory, Hidalgo (2009) favours the state as a catalyser and synchronizer to solve the coordination problem between the demand and accumulation of the necessary capabilities to move up. Interestingly these updated views on government interference stand in contrast with the dominant opinion in the 1980s and formalized by the Washington Consensus of sharply reducing the state's role in the economy.

2.4 – Benefits and Challenges Arising with Technological Upgrading

Having advanced our understanding of the middle-income trap, of interest become proposed pathways for economic upgrading and increasing export complexity in order to escape the status quo (and those no trapped to avoid it). Firstly however a short detour towards the theoretical underpinnings of the importance of increased levels of skill and technology.

Following Schumpeterian tradition, UNIDO (2009: P.12) highlights that "technological learning spurs productivity growth and increases real wages". As a consequence, firms can exit the lower-technology and labour-intensive activities and move up the value chain. Additionally, relatively more complex exports (and thus production) are claimed to have stronger learning effect and more knowledge-based spillovers. Next to these benefits, Lall (2001) points to the fact that high technology products are more dynamic in world trade. Sutton (2005) adds that economic activities differ in their contribution to growth and building up firms' capabilities is a cumulative process that leads to higher real wages. Middle-income countries in turn benefit from further increases in income through enhancements in the size and willingness-to-pay of the middle class. Increased spending on differentiated and higher quality products results in extra profit margins, which can stimulate additional innovations and marketing and branding efforts: on itself important elements to kick-start the growth process. Technological upgrading can thus be interpreted as a virtuous circle, or paraphrasing UNIDO (2009: P.12) "a cause and consequence of rising income levels".

Adding to the difficulties faced by most middle-income countries are claimed path dependencies. Works by among others, Hausmann and Klinger (2006) and Hausmann and Hidalgo (2010) assume that the dynamics of a country's productive structure depend on the availability of certain non-tradable inputs and that additional non-tradable inputs are difficult to accumulate. Put differently: nations upgrade through the development of products that are largely identical to the once already produced. Moreover, Bell and Pavitt (1997) explains the cumulative build-up of competencies since integrating new technology systems requires mastery of the previous technology.

When one combines the intimidating and costly policy agenda faced by governments with proposed path dependencies faced during the upgrading process and the circular causation between moving up the ladder and increased wealth, the existence of a trap becomes less of a surprise.

2.5 – Escape Routes

In order to speed up and cheapen the costly and lengthy road of acquiring profitable niches in the world market, developing countries often turn to Foreign Direct Investment (FDI). Through reverse engineering, know-how and skilled labour transfers, lowering entry costs and opening up the value chain it is often claimed that FDI nurtures local innovation capabilities. This uncritical view unfortunately cannot be convincingly supported. As pointed out by Marano (2011: P.1) ASEAN3 countries for example substantially have failed in "internalizing the needed technologies and skills for high value-added production". While Yusuf and Nabeshima (2009: P.24) states that "international empirical evidence suggests that spillovers from FDI are modest at best". This dilemma exists because positive FDI spillovers are found to be conditional on endogenous capabilities or the "host country's absorptive capacity" (Paus 2005) and reluctantly shared by the mother company. Kemeny's empirical analysis (2010: P.1550) formalizes these endogenous capabilities by pointing to the importance of "a well-educated workforce, effective communication infrastructure, greater trust, and effective economic, social and political institutions" to reap the envisioned benefits of FDI.

Another part of the literature advocates export diversification to accelerate growth. Whilst climbing the technology ladder, increased diversification namely can ease the pressure of falling terms of trade and a standstill in value-added. Koren and Tenreyro (2007) for example provides evidence that more diversified lower economies show increased resilience to external shocks, while Parteka and Tamberi (2008) concludes that economic growth is convoyed by increasing levels of diversification. Additionally, focussing on Penang (Malaysia), Yusuf and Nabeshima (2009: P.2) argues that "the future growth of Penang's economy also calls for further diversification of tradable activities so as to complement the core electronics industry and nurture new leading sectors". Another argument favouring export diversification is the possible spillover of knowledge and skill that can arise. Export diversification however in turn hangs on the role played by middle-income firms in global value chains (GVCs).

Not only does success in entering markets depends on local-foreign production links, upgrading to increase value added, in a sense tautological, additionally stands with the local capacity to capture a share in the production chain. Or as put forward by Palma (2004), only when "anchored" in the domestic economy will these industries be growth enhancing. Humphrey and Schmitz (2002: P.13) concludes that taking advantage of global chains increasingly hangs on "an effective local innovation system". Hence, the desire to move up within the value chain, and possibly elevate the whole value depends, again, on the initial knowledge, skill and competencies of domestic suppliers.

In conclusion, middle-income countries can get stuck between lower-wage countries with abundant labour supplies and knowledge-based economies with increased value-added. The literature therefore highlights the key role of regaining competiveness by exporting complex and innovative products to address the middle-income trap. Fundamental hereby are knowledge building and technological upgrading. Requisite during this upgrading process are the "institutions, track record, or critical mass" (Gill and Kharas (2009: P.200) conducive for innovation. Additionally, a good innovation policy requires incentivising entrepreneurship, increasing the skill-set of the workforce and fostering collective learning. This costly, virtuous and partly path-dependant process is ought be smoothened by FDI inflows and export diversification. Inevitable with a trap, both require sufficient initial capabilities, skill and technology: making policies and institutions that are well designed to encourage knowledge discovery and economic upgrading even more apparent. Additionally, the experience from countries that successfully moved up shows that competitively exporting with high levels of skill, technology and value added, hereafter referred to as export complexity, is worth striving for.

3. Middle-Income Growth Slowdowns

Related empirical work on middle-income growth, among others, comes from Aiyar et al. (2013) and Eichengreen, Park and Shin (2012 and 2013). Both papers aim to advance the understanding of middle-income growth slowdowns and not only present evidence for the existence of such a trap but consequently specify the most likely causes for growth stagnations. Eichengreen et al. exclusively study countries with per capita (p.c.) GDP's in 2005 constant international purchasing power parity prices above 10,000 and define growth slowdowns as a decline in the seven-year average GDP p.c. growth rate by at least 2% after an average minimum yearly p.c. GDP growth of 3.5% the preceding seven years. Accordingly the authors find in their latest paper that economies most likely slow down when GDP p.c. in 2005 constant prices approaches I$11,000, followed by another mode around I$15,000. In addition, they report that slowdowns in the rate of Total Factor Productivity explain 85% of the slowdown in output growth and confirm the importance of skill and technology: "countries accumulating high quality human capital and moving into the production of higher tech exports stand a better chance of avoiding the middle income trap" (Eichengreen at al., 2013: P.12). More specifically, probit regressions reveal that, other things equal, increases in the share of secondary school and university graduates in the population, large shares of high-tech exports and an economy open to trade[3] reduces the probability of a slowdown. On the other hand, higher growth in earlier periods, high old age dependency, high investment ratios, and undervalued exchange rates are found to have a significant impact on an increased probability of a growth slowdown.

Aiyar et al. proposes an alternative identification procedure for growth slowdowns that does not rely on structural breaks in growth rates, and agrees that slowdowns are more prone for countries at the middle stages of development. The authors use a five-year panel of GDP p.c. growth rates to regress GDP growth on lagged income and physical and human capital. The derived residuals accordingly are defined as actual rates of growth minus the estimated rate, where a positive (negative) residual means faster (slower) growth than expected. Lastly, a slowdown in period t is considered as the situation where the difference in residuals between both t_{-1} and t and t_{-1} and t_{+1} is smaller than the 20[th] percentile of the empirical distribution of residual differences

[3] The authors report that the estimates for trade openness are not entirely consistent across specifications.

during that 5-year period. This approach thus identifies country-period observations that deteriorated substantially from expected while ensuring the slowdown is of sustained magnitude. To identify the determinants of (middle-income) growth slowdowns, Aiyar et al. combine probit specifications with Bayesian model-averaging techniques to ensure robustness. During the instances that both models overlap[4], their results point in the same direction as Eichengreen et al. Namely, favourable demographics and trade openness are associated with a reduced probability of a growth slowdown whereas high investment shares increases this chance. Other relevant significant results indicate that deregulation, good infrastructure and increased capital inflows guard against slowdowns in middle-income countries.

4. Classifying countries

When interested in the middle-income growth implications of export basket upgrading, one methodological issue to face is how to classify countries to be middle-income. A widely used criterion to do so comes from the World Bank. The World Bank classifies countries based on their Gross National Income (GNI) per capita. The most recent classification divides nations according to 2011 GNI per capita. The groups are as followed: low-income, $1,025 or less; lower middle-income, $1,026 - $4,035; upper middle-income, $4,036 - $12,475; and high-income, $12,476 or more. The original thresholds however, were chosen while taking several indicators of well-being into account: ensuring that both income and non-income measures are encapsulated. The thresholds remain constant in real terms over time since the World Bank yearly

[4] The authors result to 42 explanatory variables that can be grouped into seven categories: institutions, demographics, infrastructure, macroeconomic environment and policies, economic structure, trade structure and other.

incorporates the effect of international inflation into the thresholds. Country's classification criteria, therefore, are independent of those of other countries – i.e., countries can all be low-income, middle-income or high-income simultaneously. The World Bank's income classification series however has only been available since 1987. Since analysing the middle-income trap requires a longer time period, the series is here extended till 1970. This is done using the 1987 World Bank thresholds and the U.S. GNP deflator to calculate the corresponding 1970 - 1986 values. Using the U.S. GNP deflator to measure international inflation namely was standard practice at the World Bank up until a methodology change in 1995. Combining the original World Bank data with these calculations results in yearly current USD GNI per capita country classification thresholds for the period 2011 - 1970. Table 1 accordingly shows all middle-income countries included in the authors dataset and the time period during which these nations are classified as middle-income.

An alternative approach is offered by Felipe et al. (2012) which extends the World Bank's thresholds with Maddison's (2010) historical Gross Domestic Product (GDP) per capita data. Since the former uses GNI per capita (p.c.) in current USD and the latter constant GDP p.c. measured in 1990 Purchasing Power Parity (PPP) USD, Felipe et al. looks for thresholds in 1990 PPP USD that optimally classify countries in accordance with the income classification used by the World Bank. First, 10,080 sets of GDP p.c. (1990 PPP $) thresholds are defined, with each set composing of three thresholds separating low-, lower middle-, upper middle-, and high-income countries. Second, using GDP p.c. for each year they categorize and ordinal code each country. Lastly, the pairwise correlations of each of the resulting 10,080 classifications with the World Bank's were calculated. All data from 1987 to 2010 were pooled and used in the calculation of the correlations.

Table 1: Authors dataset (LMI = lower middle-income, UMI = upper middle-income)

Country	LMI	UMI
Albania	1985 - 2005[1]	
Algeria	1970 - 2005[1]	1980 - 1985
Argentina		1970 - 2005
Armenia	2005	
Austria		1970
Belgium		1970
Bolivia	1970 - 2005	
Botswana		2005
Brazil	1970 & 1985	1975 - 2005[1]
Bulgaria	1990 - 2000	1985 & 2005
*Cameroon**	1975-1990,	
Chile	1985 - 1990	1970 - 2005[1]
China	2000 - 2005	
Colombia	1970 - 2005	
Congo, Rep.	1970 - 1990	
Costa Rica	1970 - 1990	1975 - 2005[1]
Cote d'Ivoire	1975 - 1990	
Croatia		1995 - 2005
*Cyprus**	1975	1980 - 1985
Czech Republic		1995
Dominican Rep.	1970 - 2005	
Ecuador	1970 - 2005[1]	1980
Egypt, Arab Rep.	1975 - 2005	
El Salvador	1970 - 2005	
Estonia	1995	2000 - 2005
*Fiji**	1995 - 2000	2005
Finland		1970
Gabon	1970	1980 - 2005
*Ghana**	1970 - 1980	
Greece		1970, 1975, 1985
Guatemala	1970 - 2005	
*Guyana**	1970 - 2005[1]	
Honduras	1970 - 2005[1]	
Hong Kong		1970 - 1975
Hungary		1975 - 2005
Indonesia	1975 - 2005[1]	
Ireland		1970 & 1985
Israel		1970
Italy		1970
Jamaica	1970, 1980-	1975, 2000 & 2005
Japan		1970
Jordan	1970 - 2005[1]	1980 - 1985
Kazakhstan	1995 - 2005	
Korea, Rep.	1970 - 1975	1980 - 1990
Latvia	1995	2000 - 2005
Lithuania	1995	2000 - 2005
Malaysia	1970, 1975 & 1990	1980 - 2005[1]
Mauritius	1975	1995 - 2005
Mexico	1970	1975 - 2005
*Mongolia**	2005	
Morocco	1970 - 2005	
Namibia	2005	
New Zealand		1970
Nicaragua	1970 - 2005[1]	
Panama	1990 - 1995	1970 - 2005[1]
*Papua New Guinea**	1975 - 1995	
Paraguay	1975 - 2005	1980
Peru	1970, 1980-2005	1975
Philippines	1970 - 2005	
Poland	1975 - 1990	1995 - 2005
Portugal	1970	1975 - 1990
Romania	1975 - 2000	2005
Russian Federation	1995	2005
Saudi Arabia		1990 - 2000
*Senegal**	1970 - 1990	
Singapore		1970 - 1975
Slovak Republic		1995
Slovenia		1995
South Africa		1970 - 2005
Spain		1970 & 1985
Sri Lanka	2000 - 2005	
Syria	1970 - 2005[1]	1980
Thailand	1970 - 2005	
Trinidad & Tobago	1970	1975, 1990-
Tunisia	1970 - 2005	
Turkey	1970 - 1995	1975 - 2005[1]
Ukraine	1995 & 2005	
United Kingdom		1970
Uruguay	1985	1970 - 2005[1]
Venezuela, RB	1995	1970 - 2005[1]
*Zambia**	1970 - 1980	

[1] Excluding Albania 1995, Algeria 1980 & 1985, Brazil 1985, Chile 1985 & 1990, Costa Rica 1985 & 1990, Ecuador, 1980, Guyana 1990 &1995, Honduras 1995, Indonesia 1990, Indonesia 2000, Jordan 1980 &1985, Malaysia 1990, Nicaragua 1990 & 1995, Panama 1990 & 1995, Syria 1980, Turkey 1985 – 1995, Uruguay 1985, Venezuela, RB 1995.

* Absent in Felipe et al. country classification.

The set of thresholds that yielded the highest correlation (0.974) results in an income classification in 1990 PPP USD GDP per capita of: low-income, $1,999 or less; lower middle-income, $2,000 - $7,249; upper middle-income, $7,250 - $11,749; and high-income, $11,750 or more. As stated by the authors however, their classification for 2010 differs with the World Bank for 44 countries (Felipe et al., 2012: P.16). Based on this sizeable discrepancy and a preference for the original World Bank thresholds, the dataset build using Felipe et al. thresholds purely serves for robustness checks. Similarly as Table 1, the dataset resulting from Felipe et al. can be found in the appendix as Table A1.

5. Measuring Export Complexity

Also vital for an empirical analysis on the relationship between export upgrading and middle-income growth is the availability of quantitative measures that correctly capture the amount of technological advancement or complexity of the economy's export basket. Recent contributions by Hausmann et al. (2007), Hidalgo and Hausmann (2009) and Tachella et al. (2012) claim to just do this. These approaches, of which the first two heavily discussed in the literature, make use of trade data to form both product-level measures of complexity (or sophistication), and cross-country indexes of the technological competence and competitiveness of a country's export basket.

5.1 – EXPY

In their original contribution, Hausmann, Hwang and Rodrik are interested in different levels of productivity associated with traded goods, and whether countries specializing in higher productivity goods subsequently grow faster. In answering this question, they first construct a quantitative index that assigns traded goods an implied productivity level, denoted as PRODY. PRODY then serves as input to form the productivity level corresponding to a country's export basket, which they call EXPY. The ingenuity of their approach is to assume that goods made by high-income countries are of relatively higher productivity[5]. And therefore countries exporting a great share of rich-country goods analogously are assumed to produce with relative high productivity.

Putting the former into practice, the PRODY of each product is constructed as the revealed comparative advantage (RCA)-weighted GDP per capita of the countries exporting a product:

$$PRODY_p = \sum_c \frac{(x_{cp}/X_c)}{\sum_c (x_{cp}/X_c)} Y_c$$

With countries indexed by c, products by p, the per-capita GDP of country c by Y_c, exports of product p by country c denoted x_{cp} and total exports of country c equalling X_c. The rationale for using an RCA-weighing scheme is to prevent that country size distorts the ranking. Even when a big country exports a larger volume of a product compared with a smaller country, the PRODY index allows weighing the income of the smaller country more heavily if the product constitutes a relative bigger share of the smaller county's total exports.

The associated income-, or implied productivity-level (PRODY) of each good, thereafter lends to formulate the productivity level corresponding to a country's export basket as a whole. EXPY namely is constructed as a weighted average of the PRODY for that

[5] Hausmann et al. acknowledge a related index previously developed by Michaely (1984), called "the income level of exports", which they encountered after the distribution of their working paper and more recently the work of Lall, Weiss and Zhang (2005) who develop the very similar "sophistication level of exports".

country, where intuitively the shares of the products in the country's export basket are used as weights:

$$EXPY_c = \sum_p \frac{x_{cp}}{X_c} PRODY_p$$

Using export statistics, Hausmann et al. thus construct a proxy for what they call the productivity level associated with a country's exports. Although this paper aims at finding representative measures of export complexity, EXPY nonetheless serves well for this purpose. Firstly, the authors themselves refer several times to EXPY as a sophistication measure: inferring a possible broader use of the indicator. Also, as UNIDO 2009 describes: "Productivity levels in high-income countries reflect some 'narrow' aspects of technological sophistication, such as capital intensity or process complexity, but they also embody 'broad' aspects, such as superior market knowledge, design and logistics". Making EXPY thus a suitable measure to proxy the level of complexity embedded in a countries exports.

By construction, there exists a natural relationship between GDP per-capita and EXPY. Hausmann et al. however shows that this relationship is not purely mechanical. Country specific PRODY's of whom own exports are excluded from the calculations, namely appear largely similar (Hausmann et al., 2007: P.12). Additionally, the authors perform several regressions explaining EXPY by GDP per-capita and other covariates and report considerable deviations from the cross-national norm. More importantly, it is found that these deviations matter in terms of subsequent economic growth. Hausmann et al. present their results for a cross-section ranging from 1992-2003 and panel data dating back to 1962. For the cross-section as well as their panel estimates EXPY is found significant throughout, although with a greater dispersed and arguably smaller magnitude for the panel estimates.

Most interesting however are the panel growth regressions for different country groups, distinguished by income level. The authors use several estimation techniques whereby initial per-capita GDP, initial EXPY and human capital serve as explanatory variables. This test for heterogeneity in the estimated impact of EXPY on growth across different income levels confirms the measure as a significant predictor in lower middle-income countries. The estimated coefficients however are not solely significant at the 1% level, as was the case for the full sample, but occasionally go up to the 5% level. The results for the upper middle-income group tell a different story. EXPY enters only significant (5% level) at the 5- and 10-year Instrumental Variable specifications. Both Ordinary Least Squares and Fixed Effects show no significance at either a 99% or 95% confidence interval. It is proposed that this can be explained by the more stable EXPY values that come with development.

One might accordingly ask how this papers differs from that of Hausmann et al. Firstly, it is not clearly stated which PRODY values are used to construct EXPY's prior to 1992. Put differently, it remains unclear on which years EXPY's between 1962 and 1992 are based. Secondly, the authors do not elaborate on their definition of middle-income countries (neither as a group nor segmented as lower- and upper-middle income). And lastly, this paper differs in the choice and usage of control variables and country subgroups under consideration.

5.2 – Economic Complexity Index (ECI)

It is shown that EXPY cannot be solely explained by GDP per capita, with several countries reporting either considerable smaller or larger EXPY values as expected from their income. Nevertheless, the use of GDP p.c. in the computation process has been criticised. This critique stems from the fact that conclusions in the form of: 'become rich by exporting rich country products' seem of circular logic. Hidalgo and Hausmann (2009) therefore proposes a proxy for export complexity that likewise uses trade data, but instead solely is based on countries' diversification (the number of products a country exports), and products' ubiquity (the number of countries exporting that product). They argue that making a product requires a particular type and mix of capabilities, or chunks of embedded knowledge, and hence, countries making a product reveal having the requisite capabilities. Alternatively the authors use as analogy Lego models to explain their intuition where capabilities serve as a Lego piece, products as a Lego model and countries correspond to a bucket of Lego pieces.

In the same vein as children can only form a Lego model if their Lego bucket contains all required pieces, countries are assumed to only be able to produce the products for which all the necessary capabilities or knowledge are present. Following this reasoning, the complexity of the Lego model that can be build is restricted by the Lego pieces available. Additionally, a Lego bucket containing pieces capable of building complex models is expected to also have the necessary pieces to form simpler models. However this relationship most likely does not hold vice-versa. Finally, two Lego buckets might be able to form the same number of models, but the models both buckets can build might be very different from each other. Applying this to the real world, countries exporting more products (i.e. more diversified) can only do so when all required knowledge or capabilities are present and hence signal a complex productive structure. Similarly products exported by fewer countries, probably require more exclusive capabilities and are therefore assumed to be more complex. Interestingly, Hausmann and Hidalgo (2011: P.333) estimate the existence of between 65 and 80 capabilities; ranging from knowledge, infrastructure, legal system, geographic location, institutions, physical assets, intermediate inputs, to other non-tradable activities as ports and postal services and so on.

More specifically, the authors define diversification as the number of products a country exports with Revealed Comparative Advantage (RCA)[6], and ubiquity as the number of countries that export the product with RCA. In formula:

$$Diversity = k_{c,o} = \sum_{p} M_{cp}$$
$$Ubiquity = k_{p,o} = \sum_{c} M_{cp}$$

Here M_{cp} is defined as a matrix that is 1 if country c produces product p with revealed comparative advantage, and 0 otherwise. Remember that diversification proxies country export complexity, albeit imperfectly. This is because countries exporting the same amount of products may still produce products of different levels of complexity. Taking into account the average ubiquity of a country's export products can therefore refine diversity. In the same way products' ubiquity can be corrected by the complexity of the countries producing a product: diversity. These "complementary biases" (Hidalgo, 2009: P.8) of diversity and ubiquity can be used to refine both proxies by iteratively correcting for one another. This translates into calculating jointly and

[6] $RCA_{cp} = \frac{x_{cp}}{\sum_c x_{cp}} / \frac{\sum_p x_{cp}}{\sum_{c,p} x_{cp}}$ Where x_{cp} represents the exports of country c in product p. Hence, RCA shows the share of a product in a country's export basket to the share of that product in world trade. The authors take as threshold value an RCA of 1 but report that their results are robust to variations around this threshold.

iteratively the average value of the measure arising from the preceding iteration and is expressed as:

$$k_{c,N} = \frac{1}{k_{c,0}} \sum\nolimits_p M_{cp} \cdot k_{p,N-1} \qquad (1)$$

$$k_{p,N} = \frac{1}{k_{p,0}} \sum\nolimits_c M_{cp} \cdot k_{c,N-1} \qquad (2)$$

Inserting (2) into (1) than obtains:

$$k_{c,N} = \frac{1}{k_{c,0}} \sum\nolimits_p M_{cp} \frac{1}{k_{p,0}} \sum\nolimits_{c'} M_{c'p} \cdot k_{c',N-2} = \sum\nolimits_{c'} \widetilde{M}_{cc'}\, k_{c',N-2}$$

Where:

$$\widetilde{M}_{cc'} = \sum\nolimits_p \frac{M_{cp} M_{c'p}}{k_{c,0} k_{p,0}}$$

Finally, what the author's call the Economic Complexity Index (ECI) is the normalized eigenvector associated with the second largest eigenvalue[7] since it captures the largest amount of variance in the system:

$$ECI = \frac{\vec{K} - \langle \vec{K} \rangle}{stdev\ (\vec{K})}$$

With < > representing an average, *stdev* indicating the standard deviation and $\vec{K}$ being the eigenvector of $\widetilde{M}_{cc'}$ associated with the second largest eigenvalue.

In Hausmann, Hidalgo et al. (2011) the authors accordingly provide evidence for their claim that economic complexity predicts future economic growth. ECI in 2008 for

[7] The eigenvector of $\widetilde{M}_{cc'}$ associated with the largest eigenvalue ($k_{c,N} = k_{c,N-2} = 1$) is a vector of ones and therefore not informative.

example accounts for 75% of the variance in 2009 USD GDP p.c. for a subgroup of 75 countries with relative little natural-resource exports. Additionally they regress constant GDP p.c. growth over 10-year periods from 1978-2008 on ECI, controlled for lagged GDP, growth from natural resources and the interaction between lagged GDP and ECI. Their measure for Economic Complexity significantly contributions to growth and is found to increase the R-squared with 15%. More specifically, a one standard deviation increase in ECI, everything else equal spurs ten-year growth rates with 1.6%. After several cross-country and panel regressions over shorter and longer time-spans, ECI is found to significantly capture growth-relevant information robust to measures of export-oriented growth, openness, export diversification, country size, institutional quality, human capital and country competiveness.

5.3 – Economic Fitness

Building on the work of Hidalgo and Hausmann, Tachella et al. (2012) proposes an alternative non-monetary metric to define competitiveness in terms of export diversification – labelled as economic Fitness. The authors note that countries tend to produce every possible product within their technological limits. Therefore the fact that a high-income country exports a product is of limited information on the complexity of this product. However, they argue that if an underdeveloped country is able to export a certain product, this product most likely is of lesser complexity. Consequently, only products exported by highly competitive countries can be of high complexity. As a result, Tachella et al. (2012: P.1) argues that while “the sum of quality and complexity of its products” is an appropriate measure of a country’s competitiveness, using the same approach to proxy the complexity of products yields wrong results. The authors therefore continue in the spirit of Hidalgo and Hausmann but without the claimed conceptual and mathematical flaws of the latter. More specifically, a non-linear iteration process is used in order to correct a product's complexity for the Fitness of the less competitive, or less complex countries exporting them.

This is achieved by weighting the assigned complexity of the productive systems of a product's exporters through the inverse of their Fitness. Making use of the same M_{cp} matrix defined as 1 if country c produces product p with revealed comparative advantage and 0 otherwise, country Fitness (F_c) and product complexity (Q_p) are calculated as:

$$\begin{cases} \tilde{F}_{c,n} = \sum_p M_{cp}\, Q_{p,n-1} \\ \tilde{Q}_{p,n} = \dfrac{1}{\sum_c M_{cp} \frac{1}{F_{c,n-1}}} \end{cases} \rightarrow \begin{cases} F_{c,n} = \dfrac{\tilde{F}_{c,n}}{\langle \tilde{F}_{c,n} \rangle_c} \\ Q_{p,n} = \dfrac{\tilde{Q}_{p,n}}{\langle \tilde{Q}_{p,n} \rangle_p} \end{cases}$$

Hence, two steps compose each iteration: computing the intermediate variables $\tilde{F}_{c,n}$ and $\tilde{Q}_{p,n}$ and normalizing them. Lastly, the initial conditions are $\tilde{Q}_{p,0} = 1 \forall p$ and $\tilde{F}_{c,0} = 1 \forall c$. This way Fitness is ought to capture efficiently the intrinsic link between countries' export baskets and the embedded complexity. Arising from this strategy is that the values of interest converge to their mean. Therefore solely relative values of Fitness are of interest and hence the iteration process is continued till country rankings remain unchanged. Additionally, the authors claim that countries with a higher Fitness have a higher probability of relative high income levels (Tachella et al., 2013: P.2) but at the same time state that an analysis of the ability of their algorithm to predict growth is a complex matter which will follow in future works.

5.4 – Trade-Offs Arising With Using Trade Data

Previous notable attempts to measure a country's technological capabilities or export complexity among others include Archibugi and Coco (2004), Lall and Albaladejo

(2002), Desai et al. (2002) and Hatzichronoglou (1997). Instead of making use of trade data, these contributions however depend on a combination or quantitative accumulation of various other components (e.g. patents, R&D spending and years of schooling). The assumed seniority of the indexes by Hausmann et al., Hidalgo and Hausmann and Tachella et al. therefore stems from the fact that trade data is more accurate, better comparable across countries and time and readily available for a larger number of countries.

Important to keep in mind however is that EXPY, ECI and Fitness do not measure levels of skill and technology directly, but attempt to infer it either by assuming that rich countries export products with higher complexity or that a highly diversified export basket requires more productive knowledge. Additionally, there are some limitations arising from the use of international trade data. Most importantly is the risk that trade data do not correctly reflect the actual value added of final exports. Especially due to global value chains with geographically dispersed production, a country's exports do not necessarily reflect locally embodied skill and technology (Van Assche and Gangnes, 2010). Making this hazard arguably more prone for middle-income countries is their typical role of intermediate-assembler within high-tech industries. Hence, their export complexity may simply be a reflection of the skills, capabilities and knowledge of the countries from which they import their intermediates. Take for example China, "who is able to export huge quantities of electronic and information technology products only because it imports most of the high value-added parts and components that go into these goods". (Branstetter and Lardy, 2006: P.38). The observed level of complexity of such products thus possibly reflects the knowledge and technology embedded in imported inputs, and not per se an increased level of complexity arising during the final assembly processes.

Additionally, since customs offices do the data collection, services are excluded from trade data. This is a considerable disadvantage as services are characterized by growing in tradability, technology and transportability (Ghani and Kharas, 2010). As well as in importance for GDP growth (Mishra et al., 2011). EXPY, ECI and Fitness can therefore only be considered imperfect proxies for the complete export complexity in a given country. Unfortunately services trade data with the needed level of disaggregation and time coverage is not (yet) available[8]. Lastly, the used level of aggregation deserves attention. It would have been of preferred choice to construct the underlying product-level sophistication or complexity scores with more disaggregated data. Freire (2012) for example show that using trade data reveals products of low, medium and high complexity even within certain sub-industries. Following common logic, the more disaggregated the data, the better products and hence countries can be compared. Comforting however is the finding of Hausmann et al (2011: P.11) that the basic patterns in the data between their sets of 6-digit and 4-digit disaggregation level data "are very much consistent".

6. Export Complexity Trends

Table 2 shows the correlation between the three measures of export complexity. Used for the calculations is a dataset with 96 low-, middle- and high-income countries with consistent data available between 1970 and 2005.

---

[8] For a comprehensive overview on the process on inferring value added in trade one is referred to Mattoo, Wang and Wei (2011).

Table 2: correlation between EXPY, ECI and Fitness

	EXPY	ECI	Fitness
EXPY	1.000	0.463	0.359
ECI	0.463	1.000	0.433
Fitness	0.359	0.433	1.000

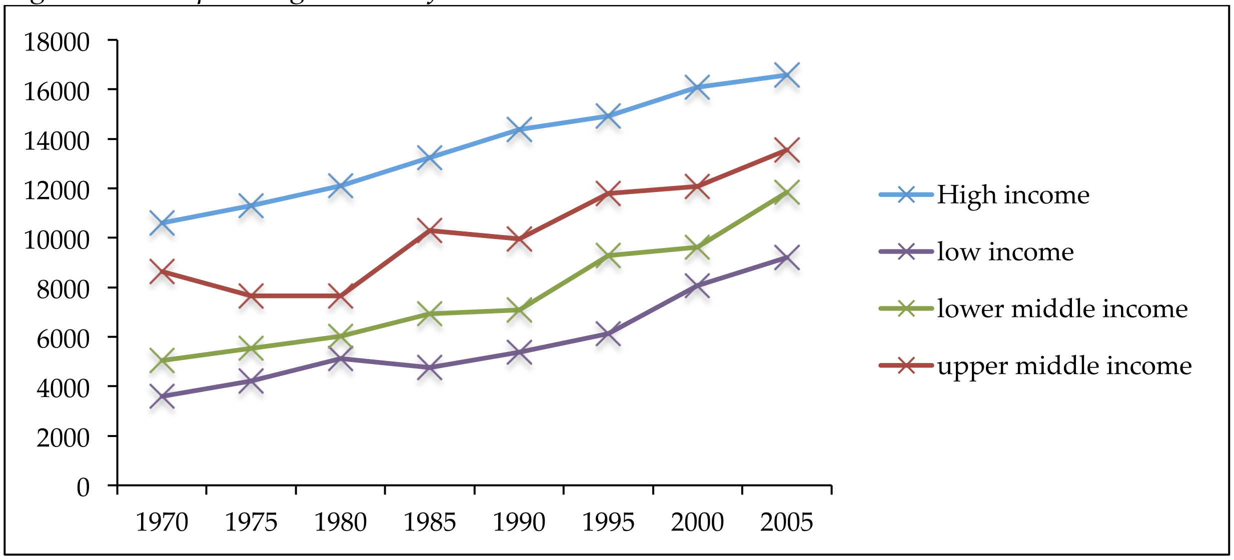
Source: Authors calculations

Although EXPY, ECI and Fitness are all build using the same sources and arise from a related ideology, the correlations are surprisingly low with none of the three above 0.5. A possible interpretation could be that all three proxies measure different aspects of export complexity or allow for a different definition of complexity, making the empirical results below broader and perhaps more informative and robust.

Alternatively, figures 2, 3 and 4 present the evolution of the average export complexity of high-, upper middle-, lower middle- and low-income countries over time[9]. EXPY (figure 2) behaves as expected with high-income countries having the highest average in each year, low-income nation the lowest and both middle-income groups reporting intermediate values. Remember that constant income levels are used during construction, implying that increased EXPY levels in many countries causes the observed upward slope. In figure 3, where ECI is of interest, a largely similar pattern in terms of average values emerges. Except for 1970, the high-income countries show the largest average ECI, followed by upper middle-income countries, lower middle-income countries and countries considered low-income. Since normalized values are under consideration, any statement concerning the development of average ECI values over time unfortunately would be irrelevant.

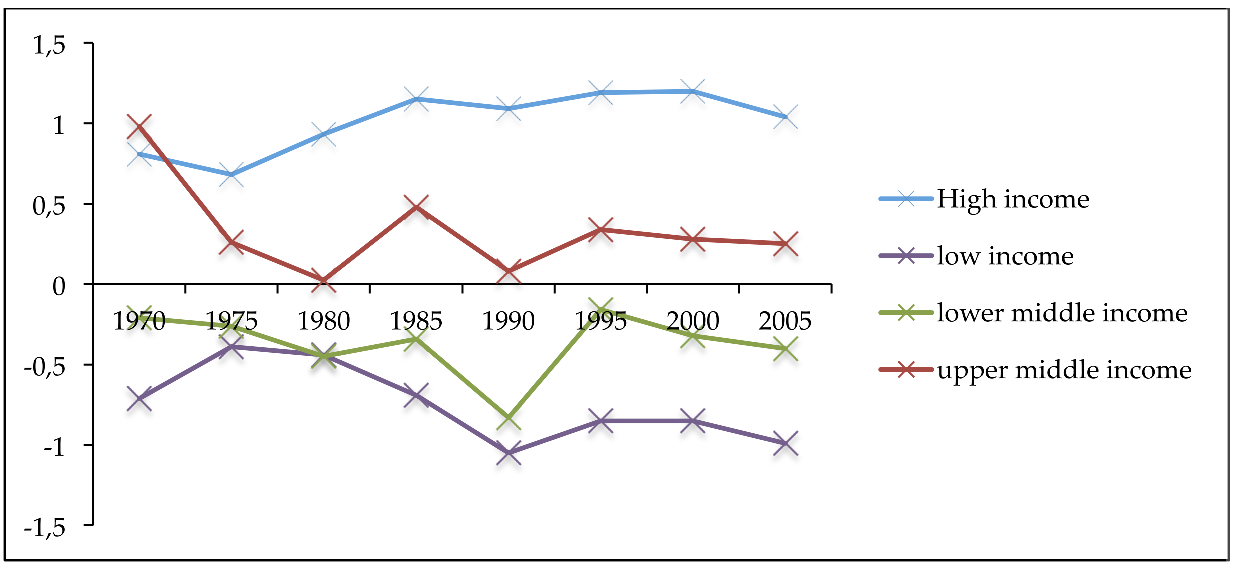
[9] Countries are classified according to the earlier elaborated on World Bank thresholds; again deflated to match the time period of choice. The number of countries included ranges between 91 in 1970 to 121 in 2005

Figure 2: Group average values of EXPY



Source: Author's calculations.

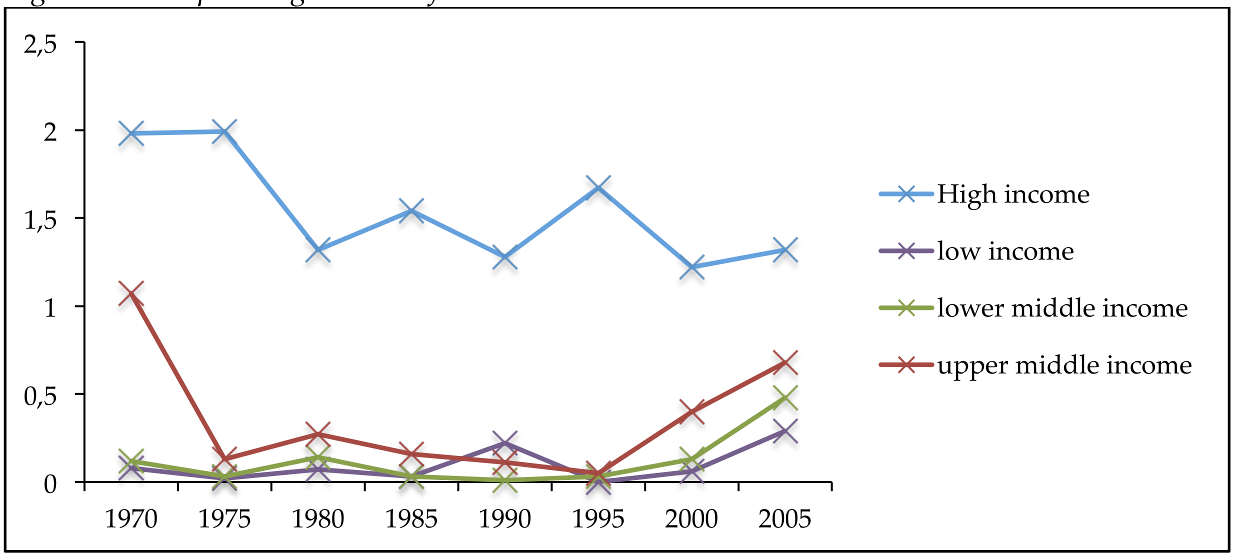
Figure 3: Group average values of ECI



Source: The Observatory of Economic Complexity

Lastly, the divide of average Fitness in figure 4 again is mostly as predicted. Of consideration might be that in 1990 the average Fitness of low-income countries is of greater magnitude as both lower middle- and upper middle-income countries. This however can only be detected once, making this observation merely an incident. Note also that figure 4 depends on the number of iterations, which, in line with the original contribution in Tachella et al. (2012), were continued till relative Fitness rankings remained unchanged.

Figure 4: Group average values of Fitness



Source: Author's calculations.

Another way to look at the data is to compare middle-income countries that follow or followed a steady development path with those considered trapped or previously trapped. Hence, placing the experience of successful countries in a general context. In order to do so two subgroups of the original dataset (Table 1) are created: one containing countries currently or previously entrapped, and one consisting of all remaining middle-income counties. Logically this asks for a working definition of the middle-income trap. In order to do so, a modified version of Felipe et al. (2012) is used.

Felipe et al. analyses historical data to define the threshold of being trapped as the median number of years that countries were classified as lower middle-income or upper middle-income before proceeding to the next income group. In other words, a country is trapped if it has been in the lower middle- or upper middle-income group longer as the historical experience. Due to an obvious element of subjectivity, this approach should however be interpreted as a suitable indication instead of a strict definition. Consequently, since 1945, the median number of years countries were classified lower middle-income before becoming upper middle-income was 10.5 years. Once upper middle-income, a median of 16.5 years was required before moving up to high-income status. Therefore countries are considered trapped after spending more then 10 or 16 years as lower middle-income or upper middle-income respectively[10].

Of interest is thus the null hypothesis that the average export complexity of countries showing effective transitions from middle to high income levels is not different from current or former trapped countries (i.e., H0: difference = 0). Table 3 shows the result of the independent t-tests to compare the average values of EXPY, ECI and Fitness between the different subgroups during 1970-2005. Note that the 1980 estimates for lower middle-income countries are absent. This is due to the fact that there were no export complexity scores available from 1980 of countries not currently or previously trapped. The null hypothesis of no difference between the average complexity of the export basket of the not trapped subgroup compared with the trapped subgroup can be rejected at either the 1% or 5% level 32 out of the 45 times. Focussing solely on comparing the means of lower middle-income countries leads to not rejecting the null hypothesis only two times. Leaving 11 instances of non-rejection for upper middle-income countries. Especially the estimates for Fitness and the year 2000 stick out in terms of no difference between levels of export complexity between countries considered not currently or previously trapped and the ones considered entrapped.

---

[10] Appendix Table A2 provides an overview of countries currently in the middle-income trap when one follows the outlined criteria.

Table 3: Comparing means – independent t-test

	Lower middle-income			Upper middle-income		
	EXPY	ECI	Fitness	EXPY	ECI	Fitness
1970	-4,45*	-3,48*	-5,56*	-2,30**	-1,91**	-1,45
1975	-2,35**	-1,82**	-2,89*	-2,62*	-2,70*	-0,12
1980				-3,18*	-2,66*	-1,25
1985	-2,94*	-2,96*	-5,57*	-2,74*	-2,48**	-1,03
1990	-2,09**	-2,91*	-7,23*	-1,53	-1,24	-2,44**
1995	-0,70	-3,30*	-2,57*	-2,47**	-2,95*	-1,99**
2000	-0,64	-3,36*	-3,68*	-0,88	-1,22	-0,80
2005	-1,96**	-3,88*	-5,55*	-0,12	-1,91**	-1,33

Source: Author's calculations.

* significant at the 1% level, ** significant at the 5% level

7. Data and Methodology

After having identified three appropriate measures to proxy the level of skill, technology and capabilities present in countries exports, or export complexity, and being able to historically classify countries considered middle income, the predictive power of EXPY, ECI and Fitness in terms of middle-income GDP per capita growth can be assessed.

Economic upgrading most likely affects growth over the longer term. It for example takes time for recently graduated high-potentials to secure the right position within the labour market, for promising innovative prototypes to be taken into production or more generally for increased skill and technology to trickle down the economy. The use of panel data therefore is of preferred choice since it allows for capturing the time series dimensions of the data and to correct for unobservable individual effects. The data represents an internally balanced, regular frequency panel with a maximum of 390 observations and 81 countries. Covered are 8 five-year periods from 1970 – 1974 through 2005 – 2009 and 7 ten-year periods spanning 1970 – 1979 through 2000 – 2009. Further, throughout are heteroskedasticity-robust standard errors reported and for all regressions fixed time effects are introduced to capture any common factors that did not vary between individual countries, such as a universal boom or global financial crisis. The choice for this time period is guided by two considerations. Firstly, reliable trade data and reporting of some of the control variables started in the late 1960's. Secondly, shark differences in growth rates between countries after reaching middle-income levels mostly became apparent during the last 40 years.

Consistent during the econometric analysis is middle-income economic growth as dependent, or left-hand variable. Growth is measured as the five or ten-year growth rate of Purchasing Power Parity (PPP) converted GDP per capita (chain series) in 2005 international dollars from the Penn World Tables 7.1 (PWT). Guided by the standard growth literature and strengthened by the results derived by Eichengreen et al. (2013) and Aiyar et al (2013) and the previous theoretical debate, initial output and measures accounting for differences in human capital and institutional quality serve next to either EXPY, ECI or Fitness in the baseline model as control variables. Additionally, export diversification, trade openness and investment levels are taken into account to ensure robustness of the derived results.

Fortunately, the ECI rankings are freely available via The Observatory of Economic Complexity[11]. Following the methods described above, The Observatory combines data from the United Nations (UN) Commodity Trade Statistics Database (COMTRADE) with the Feenstra et al. (2005) World Trade Flows dataset to construct ECI rankings based on 4-digit standard international trade classifications (SITC rev. 2) dating back till 1964. The UN Database provides international merchandise trade statistics reported by national statistical agencies and standardised by the UN statistics Division in multiple classifications. The World Trade Flows data (Feenstra, Lipsey, Deng, Ma and Mo) contains bilateral trade flows for the period 1962-2000, disaggregated at the 4-digit SITC rev. 2. These data are drawn from the UN COMTRADE database, are cleaned and made compatible and compromise from 1970 and onwards over 163 regions and 690 commodities. Although global export data at even higher levels of disaggregation (6-digit level) can be directly obtained from the COMTRADE database, the Feenstra et al. dataset differentiates itself by covering a longer time-period and being more comprehensive in scope without as many missing observations.

Using EXPY and Fitness as explanatory variable however requires the author's calculations. EXPY and PRODY are measured in 2005 I$ per person from PWT 7.1. Following the original contribution, the World Trade Flows and COMTRADE database serve as the source of export data: the former for the period 1969 – 1999 and the latter to cover the years 2000 – 2006. Yearly PRODY values are calculated for all commodities included, limited to the fact that countries with a population of 500,000 are excluded

---

[11] Simoes, AJG. & Hidalgo, CA. (2011). 'The Economic Complexity Observatory: An Analytical Tool for Understanding the Dynamics of Economic Development.' Workshops at the Twenty-Fifth AAAI Conference on Artificial Intelligence, http://atlas.media.mit.edu/rankings/ 12-07-2013].

from the calculations. Lastly, in line with Hausmann et al. PRODY values used to construct EXPY's for year t are the average of the PRODY from t_{-1}, t and t_{+1}. Similarly, for Fitness the data by Feenstra et al. and COMTRADE are as well combined. Accordingly, the formula's outlined in 4.3 are followed and iterated, depending on the year under consideration, between 16 and 22 times.

Continuing the data description, the PWT additionally are the source for initial output, trade openness and the investment share of the economy. Initial output takes the form of 2005 international $ PPP converted chained GDP per capita, while trade openness is defined as exports plus imports divided by GDP in constant prices and investments equals the investment share of real GDP per capita. Human capital is represented by the Barro-Lee Educational Attainment Dataset percentage of a country's population that completed secondary schooling and institutional quality is taken from the World Bank Rule of Law index. This index captures the perceived confidence in and quality of the rules of society, and particularly the quality of contract enforcement, property rights, the police, and courts, as well as the probability of violence and crimes. Lastly, controlling for export diversification happens via the commonly used Herfindahl index at the 4-digit SITC rev. 2 level (sometimes referred to as the Hirschman-Herfindahl index). This index sums the squared shares of each product in total country exports[12]. Since lower values indicate export diversification, the result of $(1 - Herfindahl_c)$ is used throughout the regression analysis to make the coefficients more intuitive.

In order to control for business cycle fluctuations, initial export diversification and initial openness enter all calculations as the three-year average surrounding the starting

[12] $Herfindahl_c = \sum_p \left(\frac{x_{cp}}{\sum_p x_{cp}}\right)^2$ Exports of product p by country c indexed as x_{cp}

year of each growth cycle. Investment share on the other hand is averaged over the first five years of each growth cycle. Meaning that for the five-year panels this control variable can be considered as fully levelled. In the ten-year panels however the level effect will only cover the first five years of the cycle. This allows to simultaneously test the effect of investments as a level and lagged explanatory variable. A final note on the right-hand side variables concerns the Rule of Law index. Data from this index namely occasionally is missing in the early years of the dataset. Therefore for some countries the earliest value available is used in the growth regressions. Since the Rule of Law index is substantially persistent over time (Hausmann, Hidalgo et al., 2011) this approach seems satisfactory.

8. Growth Regressions

The next set of tables present the results of Ordinary Least Squares (OLS) Period Fixed Effects and OLS-Period and Country Fixed Effects regressions. Of interest is the predictive power of export complexity, proxied by EXPY, ECI and Fitness, in terms of GDP per capita growth.

8.1 – Ordinary Least Squares Regressions with Period Fixed Effects

The OLS regressions with Period Fixed Effects shed a first light on the empirical relationship between export complexity and middle-income growth. Looking at Table 4 with the five-year growth rate of real per capita GDP as dependent variable, export complexity enters only once significant. This result is found in the baseline model of EXPY (column 1), where EXPY reports positively significant at the 5% level. However, when export diversification, trade openness and investments are controlled for the significance gets lost. ECI and Fitness both fail to have a statistically significant effect on growth at conventional confidence levels in either their baseline or extended model.

Table 4: dependent variable: five-year growth rate of real per capita GDP

	(1)	(2)	(3)	(4)	(5)	(6)
Initial GDP p.c. (ln)	-0.0351*	-0.0308	-0.0316	-0.0278	-0.0167	-0.0208
	(0.021)	(0.022)	(0.021)	(0.025)	(0.019)	(0.018)
Initial EXPY (ln)	0.0723**	0.0481				
	(0.035)	(0.040)				
Initial ECI			0.0222	0.0135		
			(0.014)	(0.019)		
Initial Fitness					0.0036	0.0055
					(0.010)	(0.009)
Initial Schooling (ln)	0.0355**	0.0195	0.0351**	0.0209	0.0437**	0.0240
	(0.016)	(0.015)	(0.017)	(0.015)	(0.017)	(0.016)
Initial Rule of Law	0.0164***	0.0105*	0.0153**	0.0102	0.0179***	0.0114
	(0.006)	(0.006)	(0.006)	(0.007)	(0.006)	(0.006)
Initial Export Diversification		0.1512**		0.1267		0.1559
		(0.076)		(0.104)		(0.076)
Initial Openness (ln)		0.0174		0.0169		0.0159
		(0.014)		(0.014)		(0.014)
Investment Share (log)		0.0887***		0.0861***		0.0982
(5-year average)		(0.024)		(0.024)		(0.024)
Constant	-0.4157*	-0.6415**	0.2133	-0.2031	0.0511	-0.3378
	(0.246)	(0.264)	(0.173)	(0.274)	(0.152)	(0.189)
Period Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Periods	8	8	8	8	8	8
Countries	81	81	77	77	78	78
Observations	390	389	377	376	384	383
Adjusted R-squared	0.19	0.25	0.18	0.23	0.18	0.24

Heteroskedasticity-robust standard errors in parentheses
* Significant at 10% level, **significant at 5% level, ***significant at 1% level.

Additionally, initial Schooling and initial Rule of Law follow EXPY in reporting significant and positive coefficients in all baseline models while unable to do so at the 1% or 5% significant level once supplementary explanatory variables are introduced. The full model with EXPY as proxy for export complexity produces the highest goodness-of-fit, with an R-squared of 0.25 and Rule of Law, Export Diversification and Investment Share positively significant at 10%, 5% and 1% respectively. Investment Share is also found significant in the full ECI-model, albeit being the only explanatory variable. The estimates further do not show that trade openness and initial wealth significantly affect future growth.

Table 5: dependent variable: ten-year growth rate of real per capita GDP

	(1)	(2)	(3)	(4)	(5)	(6)
Initial GDP p.c. (ln)	-0.1121***	-0.0984**	-0.1070***	-0.0955**	-0.0605*	-0.0597
	(0.039)	(0.042)	(0.040)	(0.025)	(0.036)	(0.037)
Initial EXPY (ln)	0.1805***	0.1484**				
	(0.063)	(0.070)				
Initial ECI			0.0703***	0.0623*		
			(0.026)	(0.019)		
Initial Fitness					0.0069	0.0098
					(0.016)	(0.016)
Initial Schooling (ln)	0.0833**	0.0566*	0.0816**	0.0608*	0.1006***	0.0673**
	(0.034)	(0.032)	(0.036)	(0.015)	(0.037)	(0.034)
Initial Rule of Law	0.0367***	0.0282**	0.0338***	0.0280**	0.0403***	0.0301**
	(0.012)	(0.012)	(0.012)	(0.007)	(0.012)	(0.012)
Initial Export Diversification		0.2762*		0.1749		0.3017**
		(0.145)		(0.104)		(0.146)
Initial Openness (ln)		0.0430		0.0472		0.0406
		(0.029)		(0.014)		(0.029)
Investment Share (ln) (First 5-year average)		0.0821*		0.0819*		0.1035**
		(0.044)		(0.024)		(0.045)
Constant	-0.8456*	-1.2311**	0.7453**	0.1356	0.2712	-0.3481
	(0.453)	(0.500)	(0.332)	(0.274)	(0.290)	(0.360)
Period Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Periods	7	7	7	7	7	7
Countries	77	77	74	74	74	74
Observations	336	335	326	325	333	332
Adjusted R-squared	0.27	0.30	0.27	0.30	0.24	0.28

Heteroskedasticity-robust standard errors in parentheses
* Significant at 10% level, **significant at 5% level, ***significant at 1% level.

The estimates of the ten-year panel OLS-Period Fixed Effects, presented in Table 5, are significant for EXPY and ECI in both their full and baseline model. In line with the five-year panel Fitness however still lacks significance. The significance of export complexity is strongest in the baseline model of EXPY where a 10% increase in initial EXPY, ceteris paribus is expected to increase 10-year GDP growth with a minimal 1.8%. In comparison, ECI in the full model (column 4), while only significant at the 10% level, is expected to do so with just 0.6%. Other notable differences compared with Table 2 are that the results are indicative for (conditional) convergence and that initial Schooling and Rule of Law remain significant, although sometimes only within a 90% confidence interval, in all three full models. Additionally, initial Openness proves again insignificant in explaining middle-income growth while Export Diversification is found weakly significant only when entered in conjunction with ECI and Fitness. Lastly, as was the case for the 5-year panels, the regressions indicate that higher investments positively affect GDP p.c. growth.

The OLS regressions with Period Fixed Effects allow for some preliminary conclusions. Export complexity proxied by EXPY and ECI positively and significantly predict growth solely when a 10-year period is taken into account. Fitness is not found significant. Better quality human capital and rule of law positively contribute to growth in subsequent periods, with both an increase in size and significance for the 10-year panel compared with its 5-year counterpart. In general, a diversified export basket and being open to trade do not convincingly predict growth for middle-income countries, whilst the investment share of GDP, especially in levels, does turn out significant. Additionally, the significance of initial per-capita GDP in Table 3 indicates income convergence over the longer term even within countries all classified as middle-income. Note however that the convergence effect looses significance if fitness is controlled for. Lastly, the variables contained in Tables 2 and 3 jointly account for between 18% and 30% of the variance in growth rates.

8.2 – Ordinary Least Squares Regressions with Period and Country Fixed Effects

The previously reported estimates, although informative in nature, are however likely to be biased because of omitted variables in the form of unobserved heterogeneity. By not taking into account unobserved time-invariant country characteristics (fixed at least over a longer period), that correlate with the other explanatory variables, the least square estimator will be biased and inconsistent. Accordingly, a country Fixed Effects framework, or "within" estimator allows to observe each country in more than one period so that the fixed omitted variables take on the same value in each observation. Put differently, the impact of changes in export complexity on growth rates within countries is estimated. Inevitable this technique discards a great deal of variation in the explanators. This however is a fair price to pay considering that solely the explanatory power of export complexity on growth is of interest.

The growth regressions with both period and country fixed effects (Table 6) report a lack of significance for export complexity to predict middle-income growth. In column 3 initial Fitness is marginally significant at the 10% level. In all other regressions the complexity variables do not differ significantly from zero at confidence levels of 10% or better. Once unobserved heterogeneity is controlled for, initial per-capita GDP enters strong and significant. Hence, the convergence effect again seems to matter for economic growth. The difference in size and significance compared with Tables 4 and 5 could indicate that previously unobserved convergence effects are now more effectively captured by initial GDP. Investment Share is found highly significant when the dependent variable is the five-year growth rate while failing to do so when taking a ten-year perspective. Again this indicates that investments contribute to growth in levels instead of lags.

Table 6: dependent variable: five and ten-year growth rate of real per capita GDP

	Five-year panel			Ten-year panel		
	(1)	(2)	(3)	(4)	(5)	(6)
Initial GDP p.c. (ln)	-0.2492***	-0.2414***	-0.2605***	-0.5452***	-0.5355***	-0.5460***
	(0.046)	(0.047)	(0.048)	(0.072)	(0.075)	(0.075)
Initial EXPY (ln)	-0.0189			-0.0021		
	(0.063)			(0.080)		
Initial ECI		-0.0249			-0.0063	
		(0.026)			(0.037)	
Initial Fitness			0.0110*			0.0011
			(0.007)			(0.013)
Initial Schooling (ln)	-0.0469	-0.0564	-0.0472	-0.0421	-0.0482	-0.0422
	(0.034)	(0.035)	(0.035)	(0.047)	(0.050)	(0.048)
Initial Rule of Law	0.0038	0.0021	0.0041	0.0120	0.0096	0.0120
	(0.008)	(0.009)	(0.008)	(0.012)	(0.012)	(0.011)
Investment Share (ln)	0.1504***	0.0821***	0.1549***	0.0676	0.0618	0.0677
(First 5-year average)	(0.032)	(0.044)	(0.033)	(0.055)	(0.053)	(0.057)
Constant	2.0246***	0.1421***	1.9287***	4.6635***	4.6076***	4.6449***
	(0.642)	(0.393)	(0.403)	(0.928)	(0.673)	(0.675)
Period Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Periods	8	8	8	7	7	7
Countries	81	77	78	77	74	74
Observations	390	377	384	336	326	333
R-squared	0.57	0.56	0.58	0.78	0.78	0.78

Heteroskedasticity-robust standard errors in parentheses
* Significant at 10% level, **significant at 5% level, ***significant at 1% level.

Lastly, initial Schooling and initial Rule of Law lack explanatory power in all regressions of Table 4. In terms of goodness-of-fit, the ten-year panels are all able to produce a R-squared of 0.78 whereas the R-squared of the five-year panels lies between 0.56 and 0.58. In contrast with the model without country Fixed Effects, export complexity, human capital and schooling thus all report insignificant when accounting for unobserved heterogeneity[13]. Since controlling for unobserved heterogeneity is exactly of preferred choice, the econometric analysis suggests that export complexity, proxied by EXPY, ECI and Fitness, does not exerts an independent force on economic growth. Additionally, the fact that the regression results between EXPY, ECI and Fitness have been reasonable similar throughout, supports the robustness of this claim. Furthermore, Tables A3, A4 and A5 in the appendix present the outcomes from the same econometric procedures while using the Felipe et al. dataset. The conclusions stay the same with results showing mostly compatible size, significance and standard errors.

8.3 – Different Middle-Income Country Segments

Although thus far the explanatory power of export complexity for middle-income growth is found to be unconvincing, it is possible that segmenting certain middle-income subgroups offers additional insights. Firstly, following the methodology outlined in chapter 6, countries that are currently in the trap or were considered trapped in the past are expelled from the dataset. Note that this leaves a dataset with at its minimum 125 observations and hence conclusions drawn should be interpreted with more caution. Using techniques that control for unobserved heterogeneity, the results for the variables of interest do not differ (Table 7). Hence, export complexity is found insignificant for all regressions. Additionally the predictive power of initial wealth and investments entering in levels is confirmed. The explanation for the significant, albeit weakly, negative effect of schooling on middle-income growth is borrowed from Eichengreen et al. (2013). A first glance at the data shows that countries with the highest level of secondary education do not necessarily position top spots with their level of tertiary education.

---

[13] This result is compatible with Hausmann et al. (2007) who show comparable insignificance for Human Capital and Rule of Law.

Table 7: currently or historically trapped countries excluded
Dependent variable: five and ten-year growth rate of real per capita GDP

	Five-year panel			Ten-year panel		
	(1)	(2)	(3)	(4)	(5)	(6)
Initial GDP p.c. (ln)	-0.2821**	-0.2351**	-0.3067**	-0.5556***	-0.5308***	-0.5741***
	(0.115)	(0.115)	(0.118)	(0.176)	(0.195)	(0.177)
Initial EXPY (ln)	-0.0891			-0.1006		
	(0.096)			(0.155)		
Initial ECI		-0.0649			-0.0303	
		(0.058)			(0.070)	
Initial Fitness			0.0075			0.0123
			(0.012)			(0.015)
Initial Schooling (ln)	-0.1077*	-0.1142*	-0.0912	-0.1353	-0.1264	-0.1135
	(0.063)	(0.060)	(0.065)	(0.124)	(0.130)	(0.126)
Initial Rule of Law	-0.0314	-0.0307	-0.0405	-0.0278	-0.0322	-0.0319
	(0.027)	(0.026)	(0.027)	(0.040)	(0.042)	(0.039)
Investment Share (ln)	0.1951***	0.1548***	0.1940***	0.1329*	0.1058	0.1233*
(First 5-year average)	(0.042)	(0.038)	(0.045)	(0.076)	(0.070)	(0.070)
Constant	3.2208**	2.1517**	2.6288**	6.0151***	4.9792**	5.2510***
	(1.271)	(1.036)	(1.054)	(2.067)	(1.918)	(1.795)
Period Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Periods	8	8	8	7	7	7
Countries	62	59	59	57	55	54
Observations	151	144	147	130	125	127
R-squared	0.78	0.79	0.79	0.90	0.89	0.90

Heteroskedasticity-robust standard errors in parentheses
* Significant at 10% level, **significant at 5% level, ***significant at 1% level.

It accordingly is plausible that these countries developed a workforce very suitable for rapid growth at the earlier staged of development. But once additional skill and technology are needed struggle to move up and innovate due to a lack of university graduates.

Another distinction made is between the two stages of development within middle-income level. All five- and ten-yearly country observations namely are split between two samples with either observations of countries considered lower middle-income or with solely upper middle-income countries. The estimates, presented in Tables A6 and A7 in the appendix, again show no significance for all three export complexity proxies conform the standard 1%, 5% and 10% levels. Initial GDP p.c. enters negatively and highly significant in all regressions, while investments only do so for 5-year panels. Lastly of interest is the predictive power of the Rule of Law index for the 10-year upper middle-income panel. The regression results are consistent with the arguments made in Kehoe and Ruhl (2010) that especially for countries in the later stages of development solid institutions and a trusted legal system are important for growth.

Lastly of interest is whether inferring export complexity from products that countries export with experience can bring new insights. Rodrik (2011) namely claims that once a country starts to export a certain product, it will steadily travel up the value chain: product quality, "measured by unit prices, converges to the global frontier at a rate of 5 to 6% per annum unconditionally (Hwang 2007)". An interpretation could be that the true capability of middle-income countries to add value only is captured by export complexity indexes with a longer-term perspective. Therefore, EXPY and Fitness are re-calculated, this time solely taking products in consideration that for at least five years have been exported by countries with revealed comparative advantage. In line with the previous results however, export complexity does not convincingly predict growth (Table 8). All other estimates do follow the same pattern with significant coefficients for initial GDP and investments taken as level.

Table 8: RCA >1 for longer than five years
Dependent variable: five and ten-year growth rate of real per capita GDP

	Five-year panel		Ten-year panel	
	(1)	(2)	(3)	(4)
Initial GDP p.c. (ln)	-0.3538***	-0.3270***	-0.6235***	-0.6253***
	(0.059)	(0.048)	(0.073)	(0.073)
Initial EXPY (ln)	-0.0030		-0.0032	
	(0.009)		(0.018)	
Initial Fitness		0.0922*		0.0549
		(0.050)		(0.087)
Initial Schooling (ln)	-0.0377	-0.0455	-0.0646	-0.0696
	(0.033)	(0.029)	(0.053)	(0.055)
Initial Rule of Law	0.0023	0.0032	0.0157	0.0167
	(0.007)	(0.006)	(0.011)	(0.011)
Investment Share (ln)	0.1622***	0.1467***	0.0561	0.0546
(First 5-year average)	(0.031)	(0.027)	(0.059)	(0.059)
Constant	2.6792***	2.5123***	5.3652***	5.3665***
	(0.479)	(0.404)	(0.626)	(0.612)
Period Fixed Effects	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes
Periods	7	7	6	6
Countries	64	67	64	64
Observations	274	384	274	274
R-squared	0.68	0.65	0.79	0.80

Heteroskedasticity-robust standard errors in parentheses
* Significant at 10% level, **significant at 5% level, ***significant at 1% level.

The above reported regressions served to validate whether trade data induced proxies for export complexity are important indicators of successful middle-income growth. Based on a variety of estimation techniques and several robustness checks, it can concluded that EXPY, ECI and Fitness are incapable of being reliable and significant explanatory variables in middle-income panel regressions with as dependent variable the growth rate of real GDP per capita.

9. Conclusions

This paper attempts to shed light on the middle-income trap and the proposed solution for long-term economic and social development for entrapped countries, both subject of debate at the highest levels of policy making. The middle-income trap is best described as a competiveness problem. Countries typically advance to the middle-income stages of development by shifting resources and focus from agriculture to manufacturing. When the pool of underemployed labour empties, production costs however eventually increase and competiveness in the important export sectors erodes. At the same time are entrapped countries incapable of competing with innovative high-income nations that govern fast paced-high technology industries higher up the value chain. Therefore new sources of competiveness and hence growth are required. Intuitively, these can be found in innovation, technological upgrading and greater value adding activities.

Essential for climbing the ladder and regaining competiveness by exporting complex products are knowledge building and creating institutions conducive for innovation. Additionally important are incentivising entrepreneurship, increasing the skill-set of the workforce and fostering collective learning. This process however is hindered by the high costs, virtuous circle and path-dependency that come with it. Ought to speed up and smoothen development are FDI inflows and export diversification. Inevitable with a trap, both however require sufficient initial capabilities, skill and technology: making policies and institutions that are well designed to encourage knowledge discovery and economic upgrading even more apparent.

Logically an interest in how to objectively measure the skill and technology, or complexity, embedded in certain products arises. A correct toolkit namely allows policymakers to make better-informed decisions. Therefore this paper used three recently proposed measures of export complexity: EXPY, ECI and Fitness, to evaluate the contribution of these proxies on middle-income growth rates.

The main conclusion drawn is that trade data induced indexes of export complexity do not significantly predict middle-income growth. This result stems from several panel regressions using a dataset that ranges from 1970-2009 and exclusively host's current or former middle-income countries. Especially after the inclusion of suitable controls and correcting for unobserved heterogeneity EXPY, ECI and Fitness are found improper instruments to forecast middle-income growth rates. The results hold after segmenting the dataset in several subgroups, including lower middle-income countries, upper middle-income countries and countries that did or do not show any signs of being trapped.

A follow up question that accordingly comes to mind is whether EXPY, ECI and Fitness are incapable to proxy for export complexity or whether other factors seem more important in escaping the middle-income trap. Since trade data is used to form EXPY, ECI and Fitness, the former seems plausible. Due to global value chains and fragmented production, measuring actual value added is found to be very challenging when one only looks at trade data. Propositions for further research therefore include the use of different measure that possibly better proxy complexity and value added. Alternatively further differentiating products by cycle time (Lee, 2013; forthcoming), complexity gaps Minondo (2010), disaggregation level, type of firm ownership, and trade direction (import or export) seem of interest.

References

Aiyar, S., Duval, R., Puy, D., Wu, Y. & Zhang, L. (2013). 'Growth slowdowns and the Middle-Income Trap.', *IMF WP 71*.

Archibugi, D. & Coco, A. (2004). 'A new indicator of technological capabilities for developed and developing countries (ArCo).' *World Development* 32 (4), 629–654.

Agenor, P. & Canuto, O. (2012). 'Middle-Income Growth Traps.' *Policy Research Working Paper Series* 6210 (Washington: World Bank).

Bell, M. & Pavitt, K. (1993). `Technological accumulation and industrial growth: Contrasts between developed and developing countries.' *Industrial and Corporate Change*, Vol. 2 (2), 157±209.

Branstetter, L. G. & Lardy, N. (2006). 'China's Embrace of Globalization' *NBER Working Paper* No. 12373

Cai, F. (2012). 'Is there a middle-income trap? Theories, experiences and relevance to China.' *China and World Economy,* 20 (1), 49-61.

Desai, M., Fukuda-Parr, S., Johansson, C. & Sagasti, F. (2002). 'Measuring the technology achievement of nations and the capacity to participate in the network age' *Journal of Human Development,* 3 (1), 95–122.

Eichengreen, B., Park, D. & Shin, K. (2012). 'When fast growing economies slow down: International evidence and implications for China.' *Asian Economic Papers* 11, 42-87.

Eichengreen, B., Park, D. and Shin, K. (2013). 'Growth slowdowns redux: new evidence on the Middle-Income Trap.' *NBER Working Paper,* No. 18673.

Felipe, J., Abdon, A. M. & Kumar, U. (2012). 'Product complexity and economic development' *Structural Change and Economic Dynamics*, 23 (1), 36-68.

Flaaen, A., Ghani, E., & Mishra, S. (2013). 'How to avoid middle income traps? Evidence from Malaysia.' *Policy Research Working Paper Series,* 6427, (Washington: World Bank).

Felipe, J., Abdon, A. M. & Kumar, U. (2012). Tracking the Middle-Income Trap: What is it, Who is in it, and Why? *Levy Economics Institute, Working Paper*, 715.

Freire, C. (2012). 'Strategies for structural transformation in countries in South and South-West Asia.' *ESCAP South and South-West Asia Development Papers*, 1204.

Ghani, E. & Kharas, H. (2010). 'Overview in The Service Revolution in South Asia', edited by Ejaz Ghani, Oxford University Press.

Gill, I. & Kharas, H. (2007). 'An East Asia Renaissance: Ideas for Economic Growth.' *Washington, DC: The World Bank*.

Gill, I. & Kharas, H. (2009). 'Gravity and friction in growing east asia.' *Oxford Review of Economic Policy,* 25 (2), 190-204.

Hatzichronoglou, T. (1997). 'Revision of the high-technology sector and product classification' *OECD Science, Technology and Industry,* Working Paper, 1997/2.

Hausmann, R. & Hidalgo, C. (2010). 'Country diversification, product ubiquity, and economic divergence.' *CID Working Paper,* 201, Harvard University.

Hausmann, R. & Hidalgo, C. (2011). 'The network structure of economic output' *Journal of Economic Growth*, 16, 309-342.

Hausmann, R., Hidalgo, C., Bustos, S., Coscia, M., Chung, S., Jiminez, J., Simoes, A. & Yildirim, M. (2011). 'The atlas of economic complexity, mapping paths to prosperity' *Puritan Press*.

Hausmann, R., Hwang, J. and Rodrik, D. (2007). 'What you export matters.' *Journal of Economic Growth,* 12 (1), 1-25.

Hausmann, R. & Klinger, B. (2006). 'Structural Transformation and Patterns of Comparative Advantage in the Product Space.' *CID Working Paper*, 128, Harvard University.

Hausmann, R. & Rodrik, D. (2003). 'Economic development as self-discovery.' *Journal of Development Economics*, 72 (2), 603-633.

Hidalgo, C. (2009). 'The Dynamics of Economic Complexity and the Product Space over a 42-year Period.' *CID Working Paper*, 189, Harvard University.

Hidalgo, C., & Hausmann, R. (2009). 'The building blocks of economic complexity.' *Proceedings of the National Academy of Science*, 106 (26), 10570-10575.

Humphrey, J. & Schmitz, H. (2002). 'How does insertion in global value chains affect upgrading in industrial clusters?' *Regional Studies*, 36(9), 1017–1027.

Imbs, J. & Wacziarg R. (2003). 'Stages of Diversification' *American Economic Review*, 93(1), 63-86.

Kemeny, T. (2010). 'Does Foreign Direct Investment Drive Technological Upgrading?' *World Development*, *in press*.

Kharas, H. & Kohli, H. (2011). 'What Is the Middle Income Trap, Why do Countries Fall into It, and How Can It Be Avoided?' *Global Journal of Emerging Market Economies*, 3 (3), 281-289.

Koren, M. & Tenreyro, S. (2007). 'Volatility and development' *Quarterly Journal of Economics*, 122 (1), 243-287

Lall, S. (2001), 'Competitiveness, Technology and Skills' *Cheltenham*, Edward Elgar.

Lall, S., & Albaladejo, M. (2002). 'Indicators of relative importance of IPRs in developing countries.' *University of Oxford Working Paper*, 85.

Lee, K. (2013). 'Schumpeterian Analysis of Economic Catch-up: Knowledge, path-creation and the Middle-income Trap' *A monograph forthcoming by Cambridge Univ. Press*

Lewis, W. A. (1954). 'Economic Development with Unlimited Supplies of Labour.' *Manchester School of Economic and Social Studies*, 22, 139-91.

Marano, J. F. (2011). 'Knowledge and technology spillovers to local industry in Vietnam: the case of Piaggio Vietnam' *DEPOCEN Working Paper*, 1.

Mattoo, A., Z. Wang & S. Wei (2010). 'Tracing Value-added in International Trade: An Overview of Issues and a Proposal'. Paper presented at World Bank Trade Workshop: "The Fragmentation of Global Production and Trade in Value-Added - Developing New Measures of Cross Border Trade", June 2011.

Minondo, A. (2010). 'Exports' quality-adjusted productivity and economic growth' *The Journal of International Trade & Economic Development: An International and Comparative Review*, 19 (2), 257-287

Mishra, S., Lundstronm S. & Anand R. (2011). Service Export Sophistication and Economic Growth, *World Bank & IMF Policy Research Working Paper,* 6210 (Washington: World Bank).

Nallari, R., Yusuf, S., Griffith, B. & Bhattacharya, B. (2011). 'Frontiers in Development Policy: A Primer on Emerging Issues'. *World Bank Publications*

Ohno, K., (2009). 'Avoiding the middle-income trap: renovating industrial policy formulation in Vietnam.' *ASEAN Economic Bulletin,* 26 (1), pp. 25-43.

Palma, G. (2004). 'Flying-geese and lame ducks: Regional powers and the different capabilities of Latin America and East Asia to 'demand-adapt' and 'supply-upgrade' their export productive capacity.' *University of Cambridge*, Cambridge, UK.

Parteka, A., & Tamberi, M. (2008). 'Determinants of export diversification: An empirical investigation.' *Quaderni di Ricerca,* 327, Universita` Politecnica delle Marche.

Paus E. (2005). 'Foreign investment, development and globalization'. In: *Can Costa Rica become Ireland?* New York, Palgrave-Macmillan.

Paus, E. (2012). 'Confronting the middle income trap: insights from small latecomers.' *Studies in comparative international development*, 47 (2), 115-138.

Rodrik, D. (2004). Industrial policies for the twenty-first century. *Harvard University*.

Rodrik, D. (2011). 'The Future of Convergence' *HKS Faculty Research Working Paper Series,* RWP11-033, Harvard University.

Simoes, AJG. & Hidalgo, CA. (2011). 'The Economic Complexity Observatory: An Analytical Tool for Understanding the Dynamics of Economic Development.' Workshops at the Twenty-Fifth AAAI Conference on Artificial Intelligence, http://atlas.media.mit.edu/rankings/ 12-07-2013].

Spence, M., (2011). The Next Convergence. *The Future of Economic Growth in a Multispeed World*. Farrar, Straus and Giroux: New York.

Sutton, J. (2005). 'Competing in Capabilities: An Informal Overview.' *London School of Economics, Manuscript*, London.

Tacchella, A., Cristelli, M., Caldarelli, G., Gabrielli, A. & Pietronero, L. (2012). 'A new metrics for countries' fitness and products' complexity.' *Scientific Reports,* 2.

Tacchella, A., Cristelli, M., Caldarelli, G., Gabrielli, A. & Pietronero, L. (2013). 'Economic complexity: conceptual grounding of a new metrics for global competiveness' *Journal of Economic Dynamics and Control*, 37 (8), 1683-1691.

United Nations Industrial Development Organization (UNIDO). (2009). 'Breaking In and Moving Up: New Industrial Challenges for the Bottom Billion and the Middle Income Countries' *Industrial Development Report*, Vienna: UNIDO.

Van Assche, A. & Gangnes, B. (2010). 'Electronics production upgrading: Is China exceptional?' *Applied Economics Letters*, 17 (5), 477-482.

World Bank. (2005). 'Overview from Economic Growth in the 1900s: Learning from a Decade of Reform.' World Bank

World Bank. (2010). 'Robust Recovery, Rising Risks.' *World Bank East Asia and Pacific Economic Update*, vol. 2.

World bank. (2012) 'China 2030: Building a Modern, Harmonious, and Creative High-Income Society.' World Bank.

Yusuf, S. & Nabeshima, K. (2009). 'Can Malaysia Escape The Middle-Income Trap?: A Strategy For Penang'. *World Bank Policy Research Working Paper*, 4791.

Appendix

Table A1: (LMI = lower middle-income, UMI = upper middle-income)

Country	LMI	UMI	Country	LMI	UMI
Albania	1975 - 2005		Kuwait	1990	1995 - 2000
Algeria	1970 - 2005		Kyrgyz Republic	2000 - 2005	
Argentina	1985 & 1990	1970 - 2005[1]	Latvia	1995	2000
Armenia	1995 - 2000		Lithuania	1995 - 2000	2005
Austria		1970 - 1975	Malaysia	1970 - 1995	2000 - 2005
*Bahrain**	1985 - 2005		Mauritius	1975 - 1990	1995 - 2000
Belgium		1970	Mexico	1970 - 1995	2000 - 2005
Bolivia	1970 - 2005		Morocco	1980 - 2005	
Botswana	2005		*Mozambique**	2005	
Brazil	1970 - 2005		Namibia	1980 & 2005	
Bulgaria	1975 - 2000	2005	New Zealand		1970
Chile	1970 - 1990	1995 - 2000	Nicaragua	1970 - 1980	
China	1995 - 2005		*Norway**		1970
Colombia	1970 - 2005		*Pakistan**	2005 - 2005	
Congo, Rep	1975 - 2005		Panama	1970 - 2005	
Costa Rica	1970 - 2005		Paraguay	1975 - 2005	
Cote d'ivoire	1980		Peru	1970 - 2005	
Croatia	1995	2000 - 2005	Philippines	1975 - 2005	
Czech Republic		1995 - 2005	Poland	1975 - 1995	2000 - 2005
Dominican Republic	1975 - 2005		Portugal	1970 - 1975	1980 - 1995
Ecuador	1970 - 2005		*Qatar**	1995	1990 - 2000
Egypt	1980 - 2005		Romania	1975 - 2005	
El Salvador	1970 - 2005		Russian Federation	1995 - 2005	1990
Estonia		1995	Saudi Arabia		1990 - 2000
Finland		1970 - 1975	Singapore	1970 - 1975	1980 - 1985
Gabon	1970 - 2005[1]	1975	Slovak Republic	1995	2000 - 2005
Greece	1970	1975 - 1995	Slovenia		1995
Guatemala	1970 - 2005		South Africa	1970 - 2005	
Honduras	1980 & 2005		Spain	1970	1975 - 1985
Hong Kong	1970 - 1975	1980	Sri Lanka	1985 - 2005	
Hungary	1975 - 2000	2005	Syria	1970 - 2000	1995 - 2005
*India**	2005		*Taiwan**	1970 - 985	1990
Indonesia	1990 - 2005		Thailand	1980 - 2000	2005
Ireland	1970	1975 - 1985	Trinidad & Tobago		1970 - 1995
Israel		1970 - 1985	Tunisia	1975 - 2005	
Italy		1970 - 1975	Turkey	1970 - 2000	2005
Jamaica	1970 - 2005		United Kingdom		1970
Japan		1970 - 1975	Ukraine	1995 - 2005	
Jordan	1970 - 2005		Uruguay	1970 - 1990	1995 - 2005
Kazakhstan	1995 - 2000	2005	Venezuela, RB		1970 - 2005
Korea Republic	1970 - 1985	1990	Vietnam	2005	

[1] Excluding Argentina 1985 & 1990 and Gabon 1975.

* Absent in authors country classification.

Table A2: Countries In the Middle-Income Trap in 2011 and the year middle-income status was obtained

Lower middle-income countries		Upper middle-income countries	
Africa & Middle East		Africa & Middle East	
Cape Verde	1968	Botswana	1997
Egypt, Arab Rep.	1973	Gabon	1983
Morocco	1969	Lebanon	1995
Swaziland	1970	Mauritius	1992
Syrian Arab Republic	1984		
		Europe	
Asia		Lithuania	2000
Philippines	1968	Turkey	1997
Latin America & Caribbean		Asia	
Bolivia	1968	Malaysia	1992
El Salvador	1964		
Guatemala	1949	Latin America & Caribbean	
Paraguay	1983	Argentina	1970
		Brazil	1987
Oceania		Chile	1992
Solomon Islands	1973	Costa Rica	1993
		Jamaica	1999
		Mexico	1972
		Panama	1997
		Uruguay	1987
		Venezuela, RB	1997

Source: World Bank and authors' calculations.

Table A3: Felipe et al. country classification

Dependent variable: five-year growth rate of real per capita GDP

	(1)	(2)	(3)	(4)	(5)	(6)
Initial GDP p.c. (ln)	-0.0531***	-0.0485**	-0.0398**	-0.0368*	-0.0445**	-0.0436**
	(0.018)	(0.020)	(0.018)	(0.020)	(0.018)	(0.019)
Initial EXPY (ln)	0.0455	0.0349				
	(0.032)	(0.034)				
Initial ECI			0.0143	0.0148		
			(0.011)	(0.013)		
Initial Fitness					0.0070	0.0087
					(0.007)	(0.007)
Initial Schooling (ln)	0.0230*	0.0205	0.0200	0.0120	0.0297**	0.0222
	(0.013)	(0.014)	(0.013)	(0.013)	(0.013)	(0.014)
Initial Rule of Law	0.0201***	0.0144*	0.0176***	0.0116*	0.0210***	0.0154**
	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Initial Export Diversification		0.0603		0.0494		0.0608
		(0.079)		(0.089)		(0.078)
Initial Openness (ln)		0.0172		0.0191		0.0174
		(0.014)		(0.014)		(0.014)
Investment Share (log) (5-year average)		0.0483*		0.0602**		0.0542**
		(0.025)		(0.027)		(0.027)
Constant	0.0056	-0.1737	0.3222**	0.0390	0.3226**	0.0690
	(0.254)	(0.266)	(0.140)	(0.197)	(0.132)	(0.176)
Period Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Periods	8	8	8	8	8	8
Countries	82	82	79	79	80	80
Observations	388	385	381	375	383	378
Adjusted R-squared	0.18	0.20	0.19	0.21	0.20	0.21

Heteroskedasticity-robust standard errors in parentheses

* Significant at 10% level, **significant at 5% level, ***significant at 1% level.

Table A4: Felipe et al. country classification

Dependent variable: ten-year growth rate of real per capita GDP

	(1)	(2)	(3)	(4)	(5)	(6)
Initial GDP p.c. (ln)	-0.0917**	-0.0840*	-0.0676	-0.0631	-0.0693	-0.0623
	(0.046)	(0.046)	(0.046)	(0.047)	(0.045)	(0.046)
Initial EXPY (ln)	0.0984	0.0967				
	(0.063)	(0.063)				
Initial ECI			0.0419*	0.0529**		
			(0.022)	(0.027)		
Initial Fitness					0.0080	0.0110
					(0.012)	(0.011)
Initial Schooling (ln)	0.0847***	0.0799***	0.0731***	0.0589**	0.0971***	0.0838***
	(0.028)	(0.030)	(0.028)	(0.028)	(0.029)	(0.032)
Initial Rule of Law	0.0337**	0.0289*	0.0280*	0.0239	0.0368**	0.0315*
	(0.017)	(0.016)	(0.016)	(0.015)	(0.017)	(0.016)
Initial Export Diversification		0.0786		0.0151		0.0949
		(0.133)		(0.143)		(0.132)
Initial Openness (ln)		0.0460		0.0511*		0.0466
		(0.029)		(0.030)		(0.030)
Investment Share (ln)		-0.0039		0.0229		0.0089
(First 5-year average)		(0.048)		(0.050)		(0.051)
Constant	-0.2526	-0.5039	0.4771	0.2043	0.3964	0.1002
	(0.522)	(0.552)	(0.347)	(0.426)	(0.334)	(0.391)
Period Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Periods	7	7	7	7	7	7
Countries	76	76	73	73	73	73
Observations	335	332	329	324	334	329
Adjusted R-squared	0.25	0.26	0.24	0.26	0.25	0.25

Heteroskedasticity-robust standard errors in parentheses

* Significant at 10% level, **significant at 5% level, ***significant at 1% level.

Table A5: Felipe et al. country classification

Dependent variable: five and ten-year growth rate of real per capita GDP

	Five-year panel			Ten-year panel		
	(1)	(2)	(3)	(4)	(5)	(6)
Initial GDP p.c. (ln)	-0.3340***	-0.3463***	-0.3414***	-0.5399***	-0.5809***	-0.5521***
	(0.065)	(0.058)	(0.057)	(0.083)	(0.080)	(0.077)
Initial EXPY (ln)	-0.0181			-0.0640		
	(0.051)			(0.077)		
Initial ECI		-0.0260			-0.0580*	
		(0.023)			(0.031)	
Initial Fitness			0.0137*			0.0032
			(0.007)			(0.011)
Initial Schooling (ln)	-0.0689*	-0.0523	-0.0578*	-0.0699	-0.0621	-0.0658
	(0.040)	(0.033)	(0.035)	(0.054)	(0.048)	(0.053)
Initial Rule of Law	0.0010	-0.0003	-0.0003	0.0049	0.0025	0.0048
	(0.010)	(0.010)	(0.009)	(0.012)	(0.012)	(0.012)
Investment Share (ln)	0.1859***	0.2039***	0.2158***	0.0757	0.0798	0.0942*
(First 5-year average)	(0.045)	(0.038)	(0.038)	(0.055)	(0.051)	(0.054)
Constant	2.7834***	2.6298***	2.5573***	5.4186***	5.1765***	4.8728***
	(0.605)	(0.514)	(0.504)	(0.945)	(0.797)	(0.753)
Period Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Periods	8	8	8	7	7	7
Countries	82	79	80	76	73	73
Observations	388	381	383	335	329	334
R-squared	0.56	0.56	0.57	0.77	0.77	0.77

Heteroskedasticity-robust standard errors in parentheses

* Significant at 10% level, **significant at 5% level, ***significant at 1% level.

Table A6: Lower middle-income countries

Dependent variable: five and ten-year growth rate of real per capita GDP

	Five-year panel			Ten-year panel		
	(1)	(2)	(3)	(4)	(5)	(6)
Initial GDP p.c. (ln)	-0.2636***	-0.2618***	-0.2688***	-0.6530***	-0.6362***	-0.6193***
	(0.062)	(0.061)	(0.065)	(0.099)	(0.098)	(0.115)
Initial EXPY (ln)	0.0256			0.0735		
	(0.081)			(0.097)		
Initial ECI		0.0082			0.0406	
		(0.035)			(0.051)	
Initial Fitness			0.0057			0.0803*
			(0.023)			(0.048)
Initial Schooling (ln)	0.0075	0.0050	0.0275	0.0001	-0.0059	0.0168
	(0.043)	(0.044)	(0.044)	(0.075)	(0.077)	(0.070)
Initial Rule of Law	0.0022	0.0003	0.0007	-0.0068	-0.0125	-0.0123
	(0.011)	(0.011)	(0.010)	(0.19)	(0.017)	(0.017)
Investment Share (ln)	0.1467***	0.1468***	0.1573***	0.0581	0.0584	0.0609
(First 5-year average)	(0.041)	(0.046)	(0.041)	(0.067)	(0.069)	(0.068)
Constant	1.5526*	1.7813***	1.7401***	4.7072***	5.2697***	5.0493***
	(0.887)	(0.528)	(0.566)	(1.279)	(0.793)	(0.918)
Period Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Periods	8	8	8	7	7	7
Countries	59	55	58	56	53	55
Observations	238	228	235	209	201	208
R-squared	0.66	0.64	0.67	0.81	0.82	0.82

Heteroskedasticity-robust standard errors in parentheses

* Significant at 10% level, **significant at 5% level, ***significant at 1% level.

Table A7: Upper middle-income countries

Dependent variable: five and ten-year growth rate of real per capita GDP

	Five-year panel			Ten-year panel		
	(1)	(2)	(3)	(4)	(5)	(6)
Initial GDP p.c. (ln)	-0.2613***	-0.2792***	-0.2852***	-0.4363***	-0.4663**	-0.4730***
	(0.064)	(0.066)	(0.072)	(0.099)	(0.093)	(0.093)
Initial EXPY (ln)	-0.1168			-0.1842		
	(0.090)			(0.114)		
Initial ECI		-0.0517			-0.0561	
		(0.048)			(0.053)	
Initial Fitness			0.0079			-0.0052
			(0.009)			(0.012)
Initial Schooling (ln)	-0.0084	-0.0215	-0.0205	-0.0149	-0.0335	-0.0271
	(0.022)	(0.026)	(0.030)	(0.045)	(0.053)	(0.056)
Initial Rule of Law	0.0152	0.0136	0.0138	0.0332***	0.0293***	0.0316***
	(0.014)	(0.013)	(0.013)	(0.010)	(0.011)	(0.011)
Investment Share (ln)	0.1706***	0.1535***	0.1774***	0.0696	0.0604	0.0893
(First 5-year average)	(0.054)	(0.049)	(0.058)	(0.134)	(0.130)	(0.136)
Constant	2.9470***	2.1525***	2.0980***	5.4632***	4.1629***	4.0798***
	(1.102)	(0.640)	(0.672)	(1.065)	(0.906)	(0.945)
Period Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Periods	8	8	8	7	7	7
Countries	52	50	49	48	47	46
Observations	152	149	149	127	125	125
R-squared	0.72	0.72	0.72	0.89	0.89	0.89

Heteroskedasticity-robust standard errors in parentheses

* Significant at 10% level, **significant at 5% level, ***significant at 1% level.