



WORKING PAPER NO.21

Export Diversification and Economic Growth

Heiko Hesse



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About the Series

The Commission on Growth and Development led by Nobel Laureate Mike Spence was established in April 2006 as a response to two insights. First, poverty cannot be reduced in isolation from economic growth—an observation that has been overlooked in the thinking and strategies of many practitioners. Second, there is growing awareness that knowledge about economic growth is much less definitive than commonly thought. Consequently, the Commission’s mandate is to “take stock of the state of theoretical and empirical knowledge on economic growth with a view to drawing implications for policy for the current and next generation of policy makers.”

To help explore the state of knowledge, the Commission invited leading academics and policy makers from developing and industrialized countries to explore and discuss economic issues it thought relevant for growth and development, including controversial ideas. Thematic papers assessed knowledge and highlighted ongoing debates in areas such as monetary and fiscal policies, climate change, and equity and growth. Additionally, 25 country case studies were commissioned to explore the dynamics of growth and change in the context of specific countries.

Working papers in this series were presented and reviewed at Commission workshops, which were held in 2007–08 in Washington, D.C., New York City, and New Haven, Connecticut. Each paper benefited from comments by workshop participants, including academics, policy makers, development practitioners, representatives of bilateral and multilateral institutions, and Commission members.

The working papers, and all thematic papers and case studies written as contributions to the work of the Commission, were made possible by support from the Australian Agency for International Development (AusAID), the Dutch Ministry of Foreign Affairs, the Swedish International Development Cooperation Agency (SIDA), the U.K. Department of International Development (DFID), the William and Flora Hewlett Foundation, and the World Bank Group.

The working paper series was produced under the general guidance of Mike Spence and Danny Leipziger, Chair and Vice Chair of the Commission, and the Commission’s Secretariat, which is based in the Poverty Reduction and Economic Management Network of the World Bank. Papers in this series represent the independent view of the authors.

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Abstract

Export diversification can lead to higher growth. Developing countries should diversify their exports since this can, for example, help them to overcome export instability or the negative impact of terms of trade in primary products. The process of economic development is typically a process of structural transformation where countries move from producing “poor-country goods” to “rich-country goods.” Export diversification does play an important role in this process. We also provide robust empirical evidence of a positive effect of export diversification on per capita income growth. This effect is potentially nonlinear with developing countries benefiting from diversifying their exports in contrast to the most advanced countries that perform better with export specialization.

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Export Diversification and Economic Growth

*Heiko Hesse*¹

I. Introduction

The process of economic development is as a process of structural transformation where countries move from producing “poor-country goods” to “rich-country goods.” A precondition for this transformation is often the existence of an elastic demand for countries’ exports in world markets so that countries are able to leverage global export markets without fearing negative terms of trade effects. In many developing countries, there is often very low domestic demand so exports remain one of the few channels that in the longer run significantly contribute to higher income per capita growth rates of a country. Many countries that are commodity dependent or exhibit a narrow export basket often suffer from export instability arising from inelastic and unstable global demand, so export diversification is one way to alleviate these particular constraints. Another issue relates to the competitiveness of a country’s exports since globalization and accelerating cross-border trade exposes countries’ exports to global competition. To be successful in export diversification, countries’ exports need to be globally competitive to take advantage of leveraging world markets.

The underlying questions are why do countries diversify their exports and does it benefit countries’ economic growth? In the following we attempt to review the existing literature and arguments for export diversification as well as provide an empirical analysis of the relationship of export diversification and growth. Similar to Lederman and Maloney (2007), we provide some robust empirical evidence of a positive effect of export diversification on per capita income growth. We also introduce some nonlinearity into the dynamic growth model, a novelty in this particular growth literature. We find that the effect of export diversification on growth is potentially nonlinear with developing countries benefiting from diversifying their exports in contrast to the most advanced countries that perform better with export specialization.

The paper is organized as follows: Section II discusses theory, concepts, and country examples of export diversification, whereas section III provides the empirical analysis. Finally, section IV concludes. In the annex, we provide a comprehensive treatment of the empirical methodology and data.

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II. Export Diversification and Growth— Theory, Concepts, and Country Examples

What are the theoretical reasons that export diversification is conducive to higher per capita income growth? According to structural models of economic development, countries should diversify from primary exports into manufactured exports in order to achieve sustainable growth (Chenery, 1979; Syrquin, 1989). Vertical export diversification could according to the Prebisch-Singer thesis reduce declining terms of trade for commodity-dependent countries.

Export instability is another reason for the benefits of export diversification, which is analogous to the portfolio effect in finance. Commodity products are often subject to very volatile market prices so that countries that are dependent on these commodities may suffer from export instability. This could discourage necessary investments in the economy by risk-averse firms, increase macroeconomic uncertainty, and be detrimental to longer-term economic growth. Export diversification could therefore help to stabilize export earnings in the longer run (Ghosh and Ostry, 1994; Bleaney and Greenaway, 2001).

Endogenous growth models such as Matsuyama (1992) emphasize the importance of learning-by-doing in the manufacturing sector for sustained growth. Related to export diversification, there could be knowledge spillovers from new techniques of production, new management, or marketing practices, potentially benefiting other industries (Amin Gutierrez de Pineres and Ferrantino, 2000). Producing an expanding set of export products can be seen as a dynamic effect of export diversification on higher per capita income growth. Relatedly, Agosin (2007) develops a model of export diversification and growth where countries below the technological frontier widen their comparative advantage by imitating and adapting existing products.

Furthermore, models in the product cycle literature (Vernon, 1966; Krugman, 1979; Grossman and Helpman, 1991) obtain diversity of export products by the North innovating and the South predominantly imitating and exporting the products from cheap labor countries.

The empirical literature on the link between export diversification and per capita income patterns is small. Al-Marhubi (2000) in a conventional cross-sectional country growth regression adds various measures of export concentration to the basic growth equation and does find that export diversification promotes economic growth. These findings are robust to different model specifications. Also in a cross-sectional regression, Agosin (2007) finds that export diversification has a stronger effect on per capita income growth when a country's exports grow faster than alone. Lederman and Maloney (2007) in a dynamic cross-country panel model also find some evidence in support of diversification-led growth. Within country studies by Amin Gutierrez de Pineres

and Ferrantino (1997) as well as Herzer and Nowak-Lehmann D. (2006) examine the link between export diversification and economic growth in Chile, and their findings do suggest that Chile has benefited greatly from diversifying its export base.

In a seminal paper, Imbs and Wacziarg (2003) based on domestic production and labor data investigate the relationship between domestic sectoral concentration and per capita income patterns across countries. They find a U-shaped pattern whereby countries in their early stages of development diversify production and specialize at higher income levels. This pattern is very robust across different definitions of their sectoral concentration variable and also across different model specifications. The turning point for countries that switch from domestic diversification to specialization is fairly robust at around US\$9,000 per capita. This means that most developing countries are actually in the diversifying stage over the course of their development path.

Following their empirical investigation, Imbs and Wacziarg (2003) develop some theoretical arguments for countries' incentives to domestically diversify and then specialize. Reasons for economic diversification both include preference-based and portfolio arguments. Under certain assumptions, Engel effects imply that with increasing income levels economic agents demand a larger diversity of goods for consumption. Acemoglu and Zilibotti (1997) develop the portfolio argument whereby diversification is an endogenous process, and producers invest in a wide range risky sectors, which leads to diversification.

The theoretical reasons for specialization relate both to the Ricardian theory of trade and to agglomeration effects. Decreasing transport costs lead to a reduction in the number of domestically produced products, thus promoting specialization (Dornbusch et al., 1977). In contrast, the existence of demand externalities makes it profitable for producers to cluster so this might lead to sectoral concentration.

This pattern of domestic diversification and specialization also holds for countries' exports, as shown by Cabellero and Cowan (2006) and Klinger and Lederman (2006) but the turning point kicks in at a higher GDP per capita level so that mainly very advanced economies might benefit from concentrating their exports.

There is a new literature by Hausmann and Rodrik (2003), Hausmann, Hwang, and Rodrik (2006), and Hausmann and Klinger (2006) that analyzes the benefits of export diversification and exports in general for economic growth, both empirically and theoretically. In their framework, economic growth is not driven by comparative advantage but by countries' diversification of their investments into new activities. An essential role is played by the entrepreneurial cost-discovery process. According to the model of Hausmann and Rodrik (2003), entrepreneurs face significant cost uncertainties in the production of new goods. If they succeed in developing new goods, the gains will be socialized

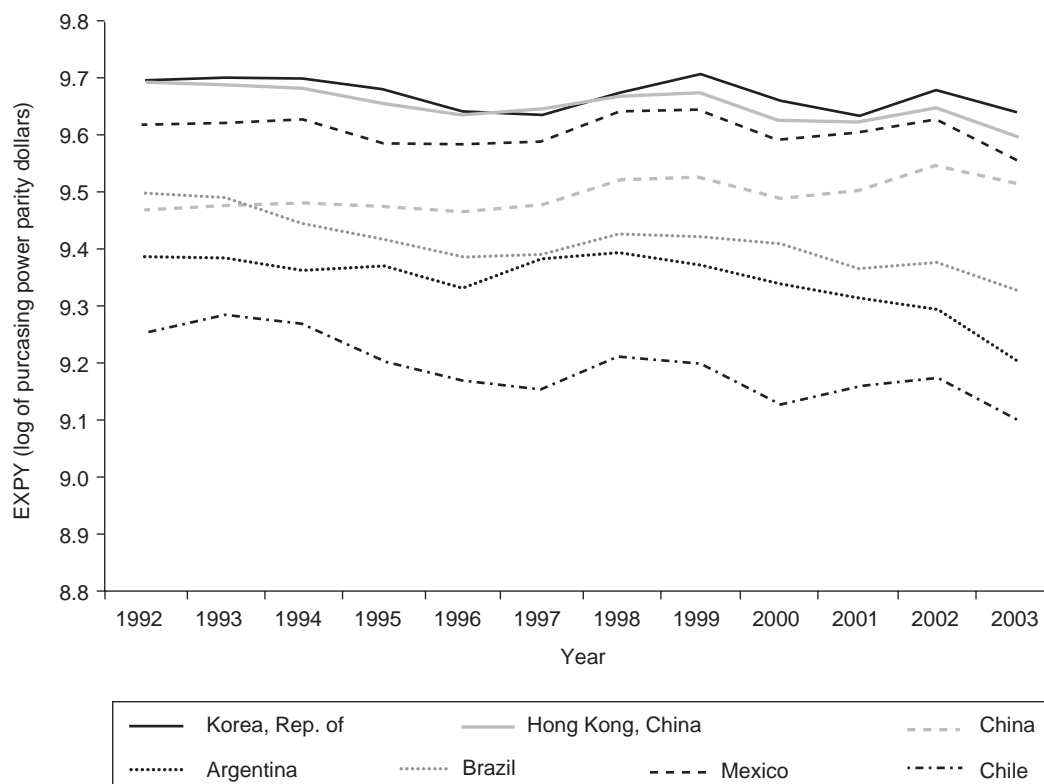
(information spillovers) but the losses from failure end up being private. This leads to an underprovision of investments into new activities and a suboptimal level of innovation. The bottom line is that according to Hausmann and Rodrik (2003), the government should play an important role in industrial growth and structural transformation by promoting entrepreneurship and creating the right incentives for entrepreneurs to invest in a new range of activities.

Relatedly to cost discoveries, foreign demand discoveries can be important (Vettas, 2000). Sometimes, domestic producers do not know whether there will be enough foreign demand from producing and exporting an existing or a new good. Only when they start exporting the product, foreign consumers become more aware of the product and its features, possibly triggering more foreign demand. Since other domestic producers of the same product observe its failure or success, imitation is an externality that could be conducive to higher growth. Agosin (2007) and Agosin and Bravo-Ortega (2007) illustrate these demand discoveries with exports of Chilean wines. Domestic production of Chilean wines goes back to the seventeenth century but only from the mid-1980s did some entrepreneurs produce wines to the tastes of foreign consumers by introducing better foreign production techniques. The discovery of this new export opportunity made wines one of the main export products in Chile.

Hausmann, Hwang, and Rodrik (2006) develop an indicator (EXPY) that measures the productivity level associated with a country's export basket. This measure is significantly positively affecting economic growth. In other words, countries that produce high-productivity goods enjoy faster growth than countries with lower-productivity goods. The authors develop a model based on the cost-discovery process that supports their empirical findings. The key is that the transfer of resources from lower-productivity to higher productivity goods with the presence of elastic demand of these goods in export markets generates higher economic growth: Countries are what they export.

As an example, consider figure 1, taken from Rodrik (2005), which graphs the income content of exports of some Asian and Latin American countries. It is striking that Argentina, Brazil, and Chile are at the bottom with the lowest level of quality of their export basket relative to their income. In comparison, we observe that Hong Kong (China), Mexico, and the Republic of Korea, with China close behind, have the highest income content of exports. Even though China has a lower level of income per capita than Argentina, Brazil, and Chile, its exports have a higher level of productivity. By diversifying their investments into higher productivity activities and goods, China is able to produce goods that do not correspond to their income level.

Figure 1: Latin America and East Asia: Income Content of Exports (EXPY)



Source: Rodrik (2005).

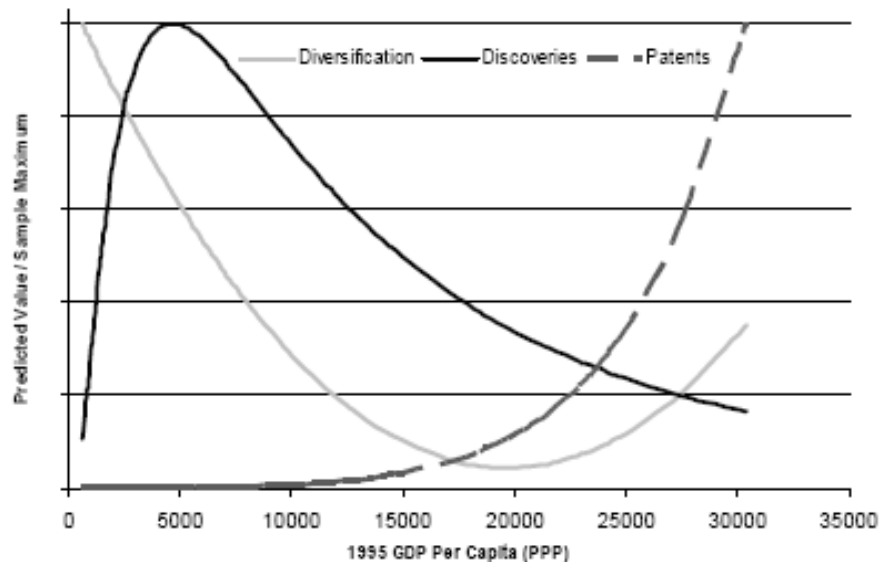
Hausmann and Klinger (2006) develop a model of structural transformation in the product space and empirically show that the speed of structural transformation depends on current export goods being closely located to other goods of more sophistication and higher value. They find that the product space is very heterogeneous, and it is desirable for a country to have a high density of the product space near its productive capabilities. It is often the case in many developing countries that they have specialized in exporting certain goods but are not able to transfer those assets and skills to the production of more sophisticated goods. This might be another argument for export diversification since it might allow countries to acquire skills and assets that could be relevant for goods in the nearby production space. In other words, there might be knowledge spillovers or learning by doing from export diversification (Amin Gutierrez de Pineres and Ferrantino, 2000).

Another aspect is the role of innovation in export diversification. In principle, there is a distinction between inside-the-frontier (goods already produced elsewhere) and on-the-frontier innovations (patents). Klinger and Lederman (2006) investigate the relationship between innovation and export diversification and find that developing countries that are in the diversifying stage are mainly characterized by a higher frequency of inside-the-frontier

discoveries. Conversely, along the line of the U-shape pattern finding of Imbs and Wazciarg (2003), more advanced countries that are concentrating their exports are characterized by a decreasing level of inside-the-frontier discovery activities but by substantially more on-the-frontier innovations. Figure 2 illustrates this pattern.

A new strand of literature investigates whether export growth is predominantly driven by growth at the extensive or intensive margin. Under extensive margin growth, countries export a wider set of products to existing or new geographical markets whereas under intensive margin growth, an increase of existing products to current markets occurs. Hummels and Klenow (2005) as well as Pham and Martin (2007) in a cross-sectional analysis find that most of the export growth is driven by growth at the extensive margin. This stands in contrast to Brenton and Newfarmer (2007), whose results in a panel data-setting from 1995–2004 suggest that exporting larger quantities of existing products matter more than exporting a wider set of products. Also, exporting existing products to new geographical markets carries a higher weight in explaining export growth than discovery of new products. The conflicting results could be potentially traced back to different levels of disaggregation and types of regression models used (cross-sectional versus time series) so more work needs to be done for a better understanding of the contributions of extensive as well as intensive margin growth to countries' export performances.

Figure 2: Diversification and Innovation



Source: Klinger and Lederman (2006).

It has often been argued that natural resource-based economies suffer from a “resource curse.” Some of the reasons point toward historical declining terms of trade of primary commodities, the possible occurrence of Dutch Disease effects through an appreciating real exchange rate, or lack of incentives of the commodity-based economy to diversify and industrialize. For instance, Sachs and Warner (2001) find a negative relationship between resource abundance and growth while the results of Gylfason (2001) indicate an inverse relationship between resource intensity and education, which according to the author implies that natural resource-based economies might not have the incentives to heavily invest in human capital accumulation.

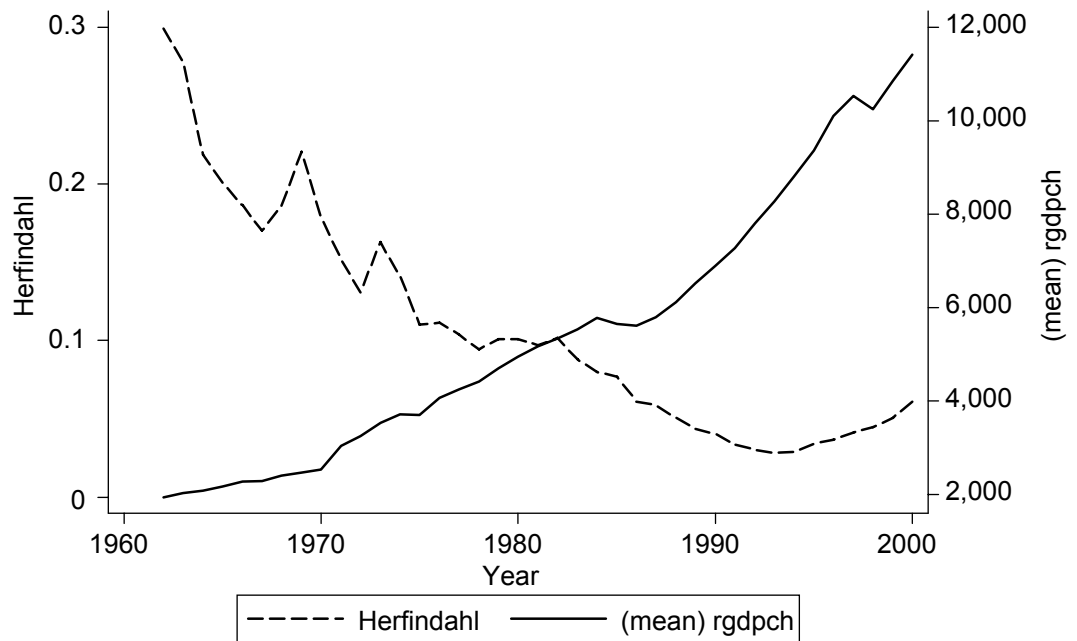
In recent years the “resource curse” view has somewhat altered. Resource abundance could bring about technological progress and new knowledge (World Bank, 2002), and some time series models do not find robust evidence for a “resource curse” (Lederman and Maloney, 2007). Also, many OECD countries such as Australia, Canada, or the Scandinavian countries started out as resource-based economies but succeeded in diversifying their economies. Bonaglia and Fukasaku (2003) argue that resource-rich, low-income countries should diversify into resource-based manufacturing or processing of primary commodities instead of following the conventional path of low-skill manufacturing. For instance, both mining and forestry have developed into knowledge-intense sectors with high technological content with upstream as well as downstream activities. Similarly, the global growth of fresh food products has led to increasing vertical diversification (processing of those products) but also horizontal diversification into nearby product groups such as cut flowers or specialty fresh vegetables for many low-income countries.

Below, we briefly discuss a few country examples where export diversification and per capita income growth have been closely associated over some stage of their development path. Figures 3–6 show the development of export concentration, measured by the Herfindahl index at the 4-digit levels, and income per capita for Malaysia, Thailand, Chile, and Uganda during the period 1962–2000.

Both Malaysia and Thailand have seen a remarkable decline in export concentration over the past 40 years. Besides moving into manufacturing exports (such as clothing and electronics), Malaysia and Thailand also pursued the development of their resource-based sectors (palm oil/rubber in Malaysia and agriculture/fish in Thailand) into higher value-added products.

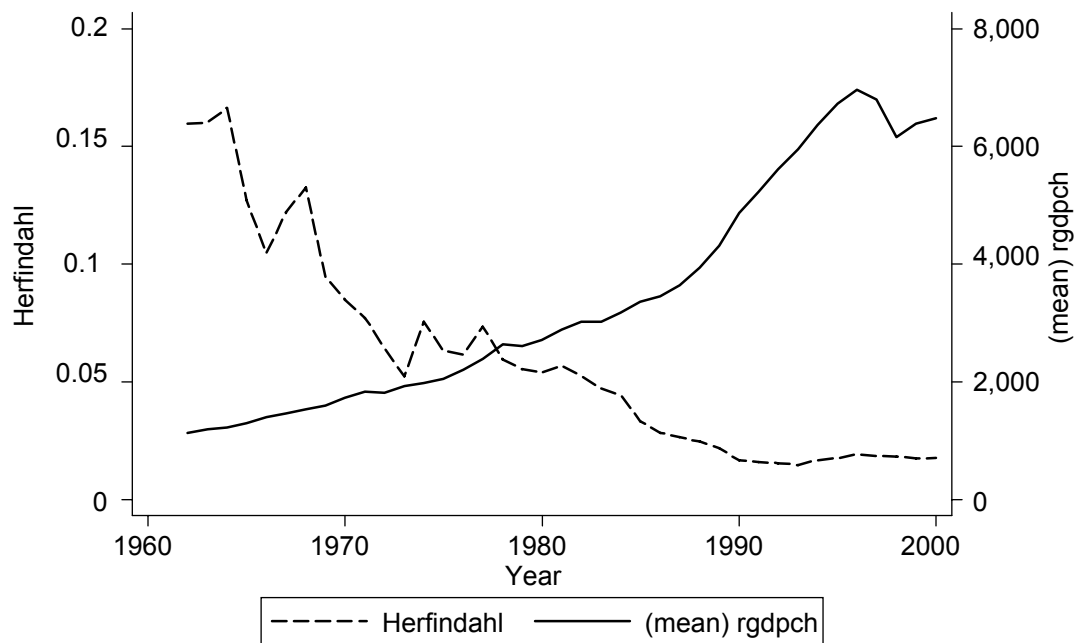
Chile is often regarded as another successful example of a resource-based economy that diversified into new export activities. Many of the new export products such as wine, salmon, fruits, or forestry products are close to Chile’s comparative advantage especially its favorable agro-ecological environment, whereas manufacturing has been almost absent in Chile’s export diversification (see Agosin and Bravo-Ortega, 2007).

Figure 3: Evolution of Export Concentration and Real GDP per Capita in Malaysia



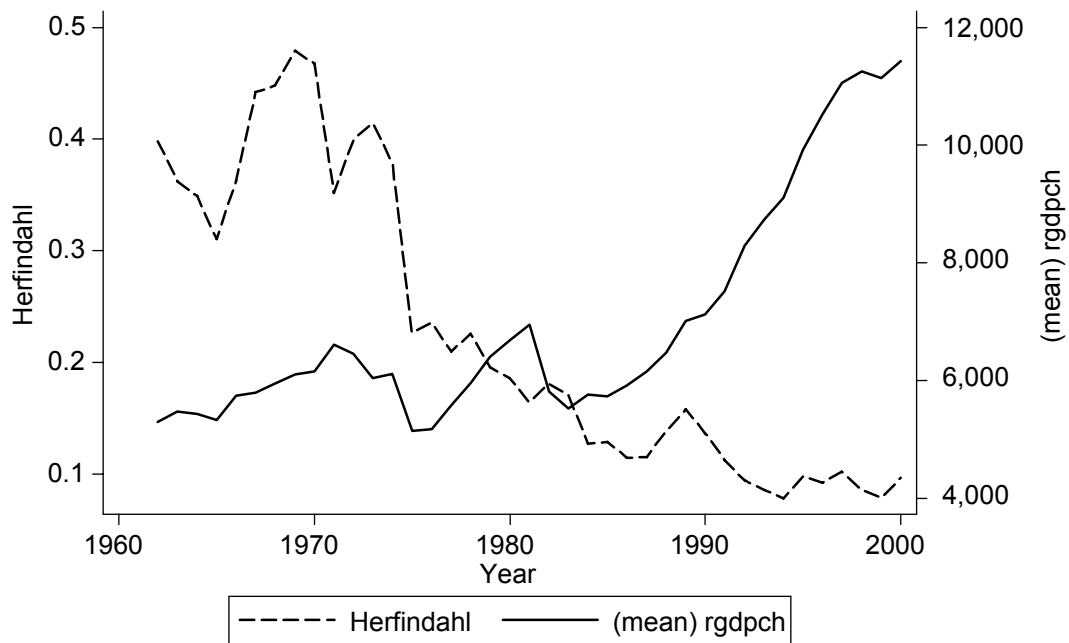
Source: Own calculations, Feenstra et al. (2005), and Penn World Table (<http://pwt.econ.upenn.edu/>).

Figure 4: Evolution of Export Concentration and Real GDP per Capita in Thailand



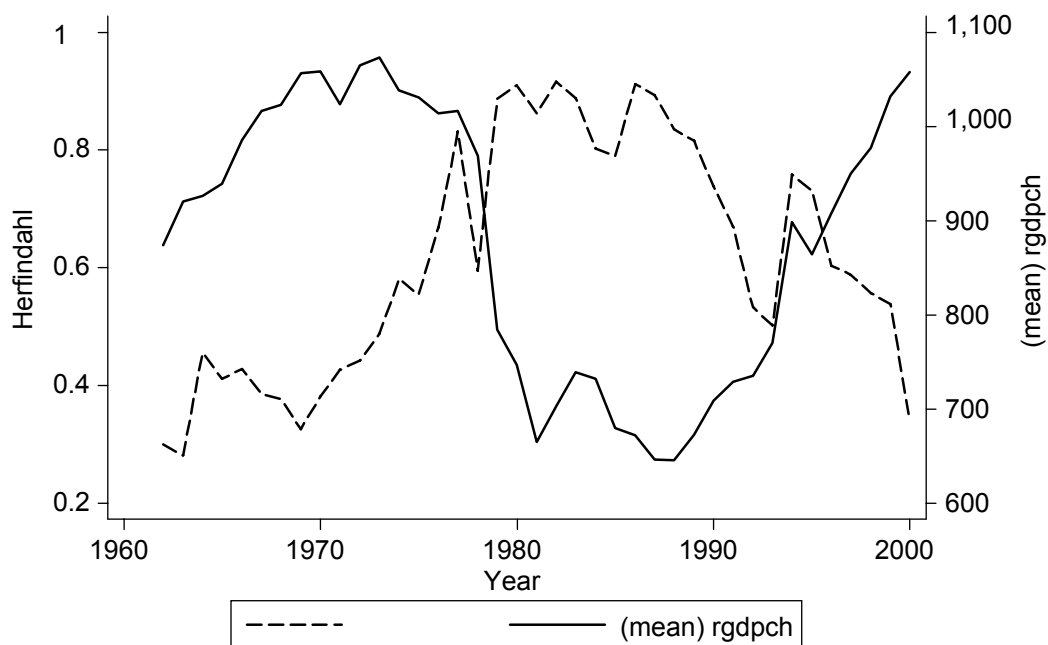
Source: Own calculations, Feenstra et al. (2005), and Penn World Table (<http://pwt.econ.upenn.edu/>).

Figure 5: Evolution of Export Concentration and Real GDP per Capita in Chile



Source: Own calculations, Feenstra et al. (2005), and Penn World Table (<http://pwt.econ.upenn.edu/>).

Figure 6: Evolution of Export Concentration and Real GDP per Capita in Uganda



Source: Own calculations, Feenstra et al. (2005), and Penn World Table (<http://pwt.econ.upenn.edu/>).

Uganda is a case where only in recent years, export diversification has taken off. It is landlocked and suffers from poor infrastructure to its coastal neighbors. Being surrounded by Lake Victoria, Uganda developed a flourishing fresh and processing fish exporting industry since the 1990s. It also heavily diversified into higher-value agricultural products such as cut flowers, fruits, and vegetables. One of the main determinants of Uganda's export success in those products lies in the sharp decline of freight rates and improvements in freight services so that these newly discovered export products could be air-lifted out of Kampala. Uganda also benefited from spillovers across sectors in cold storage systems (see also Bonaglia and Fukasaku, 2003; Chandra et al., 2007).

III. Empirical Analysis

In this section, we estimate a simple augmented Solow growth model and investigate the relationship between export diversification and income per capita growth.

Solow Growth Model

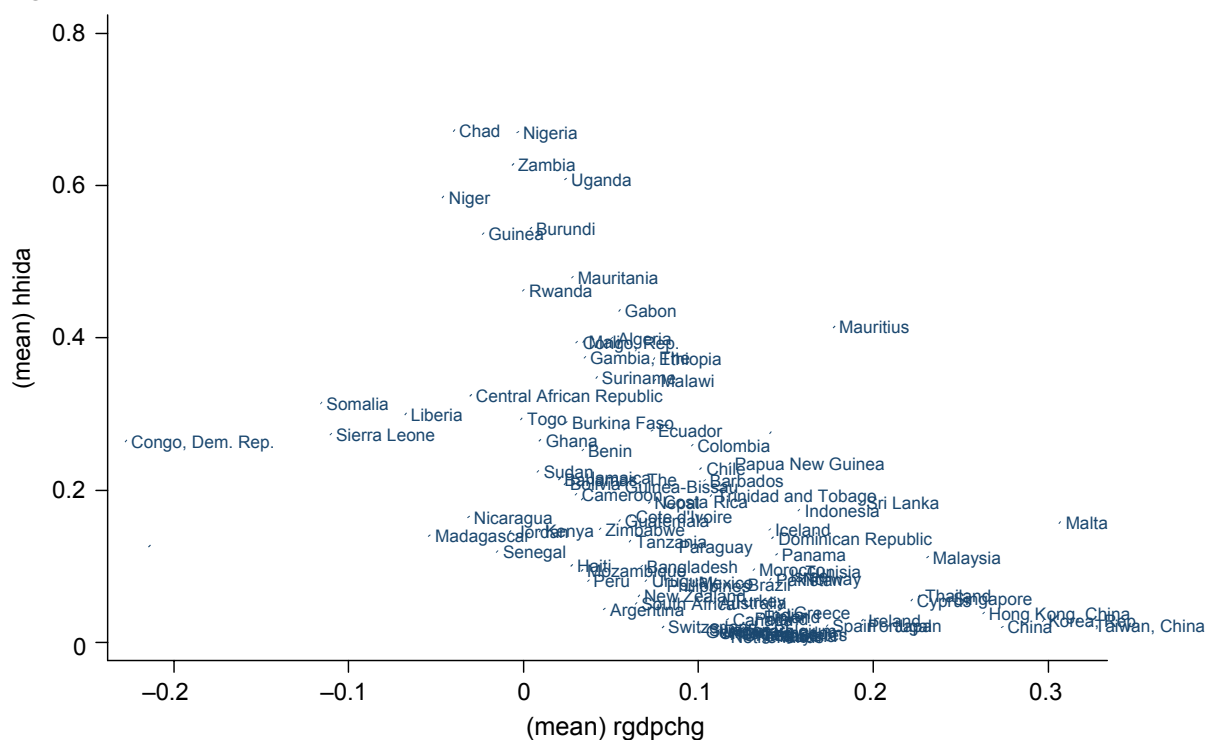
The Solow growth framework provides an intuitive and theory-based strategy for testing the relationship between export diversification and GDP per capita growth. Rather than immersing into the huge academic literature on cross-country regressions, which often has been criticized for its kitchen-sink approach by throwing in all kinds of possible explanatory factors of growth, we aim to keep the relevant explanatory variables small by relying on the predictions of the Solow growth model.

In the Solow growth model, the growth in output per worker, among others, is a function of initial output per worker, the savings rate, initial level of technology, rate of technological progress, the rate of depreciation, and the growth rate of the workforce. In the model, higher savings will cause a higher growth of output per worker whereas an increasing growth rate of the labor force (adjusted for depreciation and technological process) has the opposite effect on growth. In the augmented Solow growth model, a measure for human capital is added as an additional determinant of growth.

Results

Figure 7 presents a scatter plot of average export concentration (Herfindahl index) and cumulative GDP per capita growth over 5-year intervals for our sample period 1961–2000. There is some strong evidence of a negative correlation between both variables with a correlation coefficient of over -0.51 . As expected, many of the successful high-growing East Asian countries such as China, Korea, Malaysia, Taiwan (China), and Thailand are located in the lower right corner with relatively low levels of export concentration.

Figure 7: Export Concentration and GDP per Capita Growth, 1961–2000



Source: Own calculations, Feenstra et al. (2005), and Penn World Table (<http://pwt.econ.upenn.edu/>).

Conversely, we observe that many countries with poor growth performances in the past four decades have been Sub-Saharan African countries with a very concentrated export sector.

Column 1 in table 1 presents the dynamic panel results for the augmented Solow model.² Investment has the predicted significantly positive effect on income per capita growth whereas our population growth measure, adjusted for by the rate of technological progress and depreciation, is significantly negatively influencing growth. Both initial income and schooling have the expected sign but are not significant in this model specification.³

There is some strong evidence from column 2 that export concentration is detrimental to GDP per capita growth, as expected and found in some previous studies such as Lederman and Maloney (2007). Countries that have diversified their exports in the past decades have on average enjoyed higher per capita income growth. This finding is very robust to the exclusion of OECD countries from the sample (column 3) as well as the inclusion of an openness variable that captures total trade relative to GDP (column 4).

² All system generalized method of moments (GMM) panel estimations include time dummy variables for each period, allow for standard errors that are asymptotically robust to heteroskedasticity, and exclude Eastern European and oil exporting countries.

³ The Hansen test does not show any problems with the instruments, and there are also no second-order autocorrelation problems in the model.

Table 1: Estimation of Augmented Solow Growth Model by System GMM

	(1)	(2)	(3)	(4)	(5)	(6)
Initial GDP per capita	-0.029 (0.471)	-0.053 (0.191)	-0.074 (0.100)	-0.077 (0.022)**	-0.067 (0.082)*	-0.068 (0.064)*
Schooling	0.019 (0.534)	0.035 (0.202)	0.063 (0.039)**	0.064 (0.014)**	0.054 (0.064)*	0.032 (0.303)
Population growth	-0.346 (0.052)*	-0.292 (0.059)*	-0.299 (0.089)*	-0.315 (0.017)**	-0.255 (0.104)	-0.233 (0.133)
Investment	0.008 (0.022)**	0.006 (0.007)***	0.007 (0.020)**	0.004 (0.011)**	0.005 (0.017)**	0.007 (0.003)***
Export concentration		-0.27 (0.002)***	-0.304 (0.003)***	-0.297 (0.001)***	-0.482 (0.084)*	-1.474 (0.029)**
Openness				0.001 (0.066)*		
Export concentration ²					0.275 (0.403)	
Export concentration* GDP per capita						0.161 (0.068)*
Constant	-0.736 (0.037)**	-0.361 (0.244)	-0.158 (0.691)	-0.298 (0.268)	-0.143 (0.704)	-0.075 (0.800)
Observations	648	629	455	629	629	629
Number of countries	99	96	71	96	96	96
Time period	1965–2000	1965–2000	1965–2000	1965–2000	1965–2000	1965–2000
Hansen test	0.530	0.834	0.991	0.995	0.992	0.994
AB-test for AR(2) in diff.	0.214	0.397	0.311	0.440	0.419	0.304

Source: Own calculations.

Notes:

Dependent variable is real GDP per capita growth.

Robust *p* values in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

All estimations include time dummy variables for each period and allow for robust standard errors.

Oil-exporting and Eastern European countries are excluded as well as OECD countries in column 3.

GMM = generalized method of moments.

In columns 5 and 6, we test for the presence of nonlinearity in the relationship between export concentration and GDP per capita growth. The squared term of export concentration is positively affecting growth whereas the linear term is affecting growth negatively in column 5, even though the former is not statistically significant in this particular model specification. Similarly, the interaction between export concentration and log income is significantly positive in contrast to the strong negative impact of the linear term on income per capita growth in column 6. Overall, there is some evidence from these dynamic panel regressions that the effect of export concentration is potentially nonlinear with poorer countries benefiting from diversifying their exports in contrast to richer countries that perform better with export specialization.⁴ It is very interesting to

⁴ We obtain very similar results for the nonlinearity regressions when using ordinary least squares (OLS) or fixed effects.

find this pattern in the cross-country dynamic growth regressions, which is also supportive of Imbs and Wacziarg (2003).

IV. Conclusion

Overall, the evidence is strong that export concentration has been detrimental to the economic growth performance of developing countries in the past decades. We did not empirically investigate the specific channels through which export concentration affects per capita growth in our simple empirical model. As discussed and elaborated on in section II, one reason could be the reduction of declining terms of trade, especially for commodity-dependent countries. Another reason, put forward by Hausmann and Rodrik (2003), relates to the cost-discovery process faced by entrepreneurs and the valuable contribution of government policies to alleviate ensuing problems of coordination and information externalities. This results in a diversification of investments into a new range of activities and higher levels of growth.

Annex: Econometric Methodology and Data

We estimate a dynamic panel model of growth rather than conventional cross-sectional country growth regressions. The cross-sectional regressions suffer from various pitfalls that have been extensively discussed in the literature. *First*, they do not account for the fact that most variables are endogenously determined. For example, by construction, the initial level of income is correlated with the dependent growth variable (see Knight et al., 1993). According to Caselli et al. (1996), most macroeconomic variables are interdependent in the cross-sectional regressions so leading to a misspecified model. *Second*, cross-sectional country growth regressions suffer from an omitted variable bias because they cannot capture unobserved time-invariant country-specific factors such as the initial level of technology. *Third*, we lose a lot of valuable information by aggregating the information from our sample so we cannot analyze any dynamic relationships over time.

We use an empirical strategy that has been frequently used in the growth literature (see, for example, Caselli et al., 1996; Levine et al., 2000; Bond et al., 2001; Hoeffler, 2002; or Lederman and Maloney, 2007). We estimate dynamic panel growth models based on the GMM estimator developed by Arellano and Bond (1991). The GMM estimator overcomes the problems of the OLS estimator from the conventional cross-sectional regressions mentioned above. Taking first-differences of the regression equation removes the unobserved time-invariant country-specific effects, such as the unobserved initial level of technology, so there will be no omitted variable bias across time-invariant factors. Also, there is no problem of endogeneity within the explanatory variables because we can use lagged values of these explanatory variables as instruments. Finally, the dynamic panel estimation allows for multiple time-series observations so we don't lose much valuable information in contrast to the conventional cross-country regressions.

There are two types of GMM estimators that have been frequently used for growth regressions. On the one hand, the first-difference GMM estimator, developed by Arellano and Bond (1991), uses first-differenced equations with suitable lagged levels as instruments. On the other hand, the system GMM estimator, developed by Arellano and Bover (1995) and Blundell and Bond (1998), uses in addition equations in levels with lagged first-differences as instruments.

Bond et al. (2001) and Hoeffler (2002) argue and show that the system GMM estimator is more suited to estimate growth equations than the first-differenced GMM estimator. Many explanatory variables such as output are highly persistent so their lagged levels might only be very weak instruments for the first-differenced equations. In this situation, the first-differenced GMM estimator potentially suffers from a downward bias (Blundell and Bond, 1998) so the additional set of first-differenced instruments and equations in levels make the

system GMM estimator more efficient by overcoming the weak instrument problem in the first-differenced GMM estimator. To investigate the relationship between export diversification and economic growth, we will therefore use the system GMM estimator throughout, similar to Lederman and Maloney (2007) in their study.

We estimate a general growth equation of the following form:

$$\Delta y_{i,t} = \alpha y_{i,t-1} + x'_{i,t} \beta + \gamma_t + \eta_i + v_{i,t},$$

where $\Delta y_{i,t}$ denotes the log difference of income per capita in period t , $y_{i,t-1}$ is the log initial income, $x_{i,t}$ is a vector of potential determinants of growth, γ_t captures sample-wide time effects, η_i are the unobserved time-invariant country-specific effects, and $v_{i,t}$ is the residual error component.

Our dataset comprises up to 99 countries and data from 1961–2000 with Eastern European and oil-exporting countries being excluded. As common in the dynamic panel growth literature, we average the data across smaller time periods in order to avoid most of the short-run business cycle effects that might distort the growth estimations. In general, the time series is averaged over five-year periods from 1961–1965, 1966–1970, ..., 1996–2000, giving a time dimension of eight periods.

As usual in the academic literature (for example, Bond et al., 2001; and Hoeffler, 2002), we use per capita income growth as a proxy for output per worker growth and population growth as a proxy for labor force growth in the regression analysis.

In the basic augmented Solow growth regression, we use as the dependent-variable real GDP per capita growth, adjusted for purchasing power parity, over five-year intervals. Further components of the Solow model are the log of initial income of the period and savings rate that we proxy for by the average investment share of real GDP over each five-year period. It has been common in the literature (see, for example, Mankiw et al., 1992; Caselli et al., 1996; or Hoeffler, 2002) to assume a constant rate of technological process as well depreciation rate across countries, which sum to 0.05. We take logs of the sum of the population growth variable (which is also averaged over each five-year period) and 0.05. In the Solow model, this variable is predicted to be negatively associated with GDP per capita growth. Also, to account for differences in human capital, we include the log of years of schooling variable by Barro and Lee (2000) into the panel estimations. They collected very comprehensive data on educational attainment for a large set of countries in five-year intervals.

Our main variable of interest that is added to the augmented Solow growth regressions, export diversification, is calculated from the Feenstra et al. (2005) dataset on bilateral trade flows from 1962–2000. It is based on the four-digit SITC, revision 2, classification and recently has been frequently used in trade studies since it is very comprehensive in scope without the many missing observations

as in the usual Comtrade dataset. As far as we know for our growth exercise, the Feenstra et al. (2005) dataset has not been used before (for example, Lederman and Maloney (2007) calculate their measure from the Comtrade data), so it will be an interesting exercise to support previous findings that export diversification leads to higher GDP per capita growth rates. Specifically, for each country and year, we calculate the Herfindahl index from the disaggregated export data, and similarly to before, we average the index, this time over the periods 1962–1965, 1966–1970, ..., 1996–2000.⁵ Since the Herfindahl index is a measure of export concentration, we expect it to be negatively related to GDP per capita growth.

A small caveat on using the Herfindahl index as a measure of export concentration is in order. Many previous studies do not mention that the Herfindahl index does not capture all exports of an economy such as services, and therefore it can only be seen as an imperfect proxy for the level of export diversification in any given country. A problem is (see Imbs and Wacziarg, 2003) that export data for different sectors are subject to different levels of disaggregation. In general, manufacturing data is available more disaggregated than export data on services, which makes it very hard to combine different export sectors into one coherent Herfindahl index. But we believe that our measure for export concentration is well suited to draw some reasonable inferences on the cross-country patterns of export concentration and per capita income growth.⁶

By including export concentration unconditionally into the growth regressions, we implicitly assume that the relationship between export concentration and GDP per capita growth is linear. In other words, the effect of export concentration on per capita income growth is the same regardless of the level of income. As we have discussed in section II, Imbs and Wacziarg (2003) in a seminal paper have found a U-shaped pattern of sectoral domestic concentration and per capita income across countries. Countries in their early stages of development diversify production and specialize at higher income levels.

These patterns also hold for countries' exports, as shown by Cabellero and Cowan (2006) and Klinger and Lederman (2006) in a regression of the Herfindahl index on per capita income and its squared term. We also obtain the same results for our sample. Given the nonlinearity of the relationship between export concentration and growth, we introduce some interactions terms of export concentration into the growth regressions, a novelty in this particular literature.

⁵ The Herfindahl index is the sum of squared export shares scaled by 10,000 for each country and year. It ranges from 0 to 1, and higher values constitute a more concentrated export structure.

⁶ The Herfindahl index includes items from the following broad sectors: food and live animals; beverages and tobacco; crude materials; mineral fuels, lubricants, and related materials; animal and vegetable oils, fats, and waxes; chemicals and related products; manufactured goods chiefly classified by material; machinery and transport equipment; misc. manufactured articles; and commodities and transactions not classified elsewhere.

Specifically, we include the squared term of export concentration as well as the interaction of log income and export concentration in order to test for a U-shaped pattern. The finding of a U-shaped pattern would mean that not all countries would benefit from diversifying their exports.

Finally, to test the robustness of the export concentration variable, we individually include additional control variables in the regressions such as a measure for openness as well as measures for agriculture, manufacturing, and services all relative to GDP. The appendix provides an overview of the variable descriptions and their sources. Furthermore, we change the sample periods as well as the sample of countries included to test the sensitivity of the export concentration variable.

As mentioned above, most macroeconomic variables are interdependent in the conventional cross-sectional regressions, and the GMM estimation helps to overcome these problems of endogeneity. We adopt a relatively conservative strategy and assume in the augmented Solow model that both the investment and the population growth variable are endogenously determined and that initial income as well as our schooling measure are predetermined.⁷ Similarly, we assume that all added variables to the augmented Solow model such as export concentration are also endogenously determined. As instruments in the system GMM estimation, we will use lagged levels and differences up to t-4 and also test the sensitivity of these assumptions. The assumption that export concentration is endogenously determined is sensible since exports are a main component of per capita income.

Robustness Test

Table 2 provides some further sensitivity tests. The modification of the time period in columns 1 and 2 does not change the main finding that, in general, export concentration is detrimental to economic growth.⁸ Columns 3–5

⁷ By “endogenous” we mean that, for example, investment is correlated with past and current shocks to GDP per capita growth but not with future shocks. In contrast, the assumption that initial income is predetermined implies that it is correlated with shocks to income per capita growth in the preceding five-year periods but not in the current and future periods. Hoeffler (2002) also assumes that initial income is predetermined. We also test for the sensitivity of the underlying assumptions.

⁸ Technically, this statement is not fully correct since we include initial income in the dynamic panel model so we effectively estimate a levels equation. In other words, we capture the effect of export concentration on the GDP per capita level rather than the growth rate. We also estimated a preliminary growth model that excludes initial income but uses the lagged growth rate with some further model modifications. The estimated model provides some evidence that export concentration is also negatively related to the GDP per capita growth rate. For this, we require the Herfindahl variable to be stationary, and preliminary tests confirm its stationarity. Therefore, we continue to relate the explanatory variables to the income per capita growth rate in the main text, similar to most of the academic literature, even though this is not fully technically correct. Also, figure 3 showed a strong negative correlation between the Herfindahl and income per capita growth so this supports our reasoning. Please see Bond et al. (2004) for further information in a very similar context.

individually add further control variables such as agriculture, manufacturing, and services all relative to GDP to the basic model, and the previous findings don't change.

We did not empirically investigate the specific channels through which export concentration affects per capita growth. The addition of possible channels to the growth regressions and measurement of their effects on export diversification by looking at the change of the coefficient size of the export diversification variable did not seem the right way, because this is often a very fragile exercise, and often depends on the underlying assumptions in the dynamic panel model as well as type of regression model adopted.

Table 2: Estimation of Augmented Solow Growth Model by System GMM

	(1)	(2)	(3)	(4)	(5)
Initial income	-0.035 (0.305)	0.014 (0.652)	-0.06 (0.222)	-0.071 (0.055)*	-0.1 (0.027)**
Schooling	0.034 (0.213)	0.012 (0.675)	0.054 (0.113)	0.026 (0.383)	0.05 (0.063)*
Population growth	-0.271 (0.073)*	-0.165 (0.226)	-0.392 (0.027)**	-0.252 (0.161)	-0.478 (0.002)***
Investment	0.006 (0.006)***	0.005 (0.011)**	0.007 (0.006)***	0.007 (0.006)***	0.007 (0.005)***
Export concentration	-0.226 (0.010)**	-0.167 (0.065)*	-0.165 (0.087)*	-0.284 (0.008)***	-0.207 (0.044)**
Agriculture/GDP ratio			0.001 (0.524)		
Manufacturing/GDP ratio				0.002 (0.213)	
Services/GDP ratio					0.002 (0.237)
Constant	-0.457 (0.174)	-0.538 (0.164)	-0.646 (0.062)*	-0.135 (0.666)	-0.636 (0.051)*
Observations	555	464	562	493	562
Number of countries	96	96	94	94	94
Time period	1975–2000	1980–2000	1965–2000	1965–2000	1965–2000
Hansen test	0.822	0.583	0.983	0.997	0.989
AB-test for AR(2) in diff.	0.380	0.219	0.428	0.114	0.421

Source: Own calculations.

Notes:

Dependent variable is real GDP per capita growth.

Robust *p* values in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%; all estimations.

All estimations include time dummy variables for each period and allow for robust standard errors.

Oil-exporting and Eastern European Countries are excluded.

Appendix: Variable Definitions and Sources

Variable	Description	Source
Real GDP per capita growth	Adjusted for purchasing power parity, based on the chain index and calculated over five-year intervals	Penn World Table (PWT) 6.1
Schooling	Natural log of years of schooling	Barro and Lee (2000)
Population growth	Natural logs of the sum of the population growth variable (averaged over five-year intervals) and 0.05, which proxies for the rate of technological progress and depreciation	World Development Indicators (WDI)
Investment	Investment share of real GDP per capita	PWT 6.1
Export concentration	Herfindahl index, which is the sum of squared export shares scaled by 10,000 for each country and year, based on four-digit SITC, revision 2, classification. The average over five-year intervals is taken.	Feenstra et al. (2005) and author's construction
Openness	Exports plus imports divided by real GDP per capita in 2000 constant prices. The average over 5-year intervals is taken.	PWT 6.1
Agriculture/GDP ratio	Value added of agriculture in constant 2000 US\$ as % of GDP. The average over five-year intervals is taken.	WDI
Manufacturing/GDP ratio	Value added of manufacturing in constant 2000 US\$ as % of GDP. The average over five-year intervals is taken.	WDI
Services/GDP ratio	Value added of services in constant 2000 US\$ as % of GDP. The average over five-year intervals is taken.	WDI

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Export diversification can lead to higher growth. Developing countries should diversify their exports since this can, for example, help them to overcome export instability or the negative impact of terms of trade in primary products. The process of economic development is typically a process of structural transformation where countries move from producing “poor-country goods” to “rich-country goods.” Export diversification does play an important role in this process. We also provide robust empirical evidence of a positive effect of export diversification on per capita income growth. This effect is potentially nonlinear with developing countries benefiting from diversifying their exports in contrast to the most advanced countries that perform better with export specialization.

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