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Escola de Economia e Gestão

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Export Sophistication and Quality: Crossing the two measures

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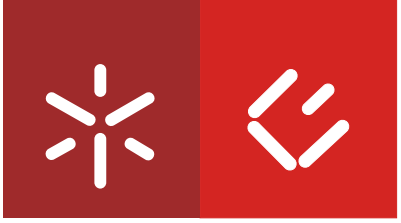

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Export Sophistication and Quality: Crossing the two measures

Master in International Business

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“It’s fine to celebrate success but it is more important to heed the lessons of failure”

Bill Gates

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Abstract

Several recent studies, established the importance of the dynamics of export sophistication for growth and development. Other studies, report a widening of the unit prices of each product reflecting the importance of distinguishing the level of exports quality of each country. The present study reveals the relationship between measures of export quality and sophistication. Quality is a within-product measure, while sophistication is an across-product measure. We question if the quality improvement strategies and climbing the sophistication ladder strategies are complements or substitutes, and address in each case which strategy was more successful. We aim to add to the literature of the area by bringing together these two branches of the international trade literature and by addressing how both strategies contribute to the countries production and growth. The results suggest higher relevance of the exports sophistication for the countries development in part due to some limitations of the quality measurement through the unit value. In trying to solve these unit value limitations, a new quality indicator by the name of "QUALY" was developed using a unit value ratio. The results of this new variable suggest a correlation of the exports quality with the exports sophistication and with development. This study suggests that the climbing sophistication strategy was more successful for the country's exports over the last years, but also suggest a complementarity between exports quality and sophistication, both having positive influence for the countries development.

Keywords: Exports. Quality. Sophistication. Export measures correlation.

Resumo

Vários estudos recentes estabelecem a importância da dinâmica da sofisticação das exportações para o crescimento e desenvolvimento. Outros estudos referem um crescimento dos preços unitários de cada produto que reflete a importância de distinguir o nível de qualidade das exportações de cada país. O presente estudo revela a relação entre as medidas de qualidade e sofisticação da exportação. Qualidade é uma medida interna dos produtos, enquanto sofisticação é uma medida entre diferentes produtos. Questionamos se estratégias de melhoria de qualidade e estratégias de aumento da sofisticação são complementares ou substitutas, avaliando, em cada caso, qual estratégia foi mais bem-sucedida. O nosso objetivo é contribuir para a literatura da área, reunindo estes dois ramos da literatura do comércio internacional e, avaliar como ambas as estratégias contribuem para a produção e crescimento dos países. Os resultados sugerem uma maior relevância da sofisticação das exportações para o desenvolvimento países, em parte, devido a algumas limitações da medição da qualidade através do valor unitário. Na tentativa de resolver estas limitações do valor unitário, um novo indicador de qualidade nomeado "QUALY" foi desenvolvido utilizando um rácio do valor unitário. Os resultados desta nova variável sugerem uma correlação da qualidade das exportações com a sofisticação das exportações e com desenvolvimento. Este estudo sugere que a estratégia de aumento de sofisticação foi mais bem-sucedida para as exportações dos países ao longo dos últimos anos, mas também sugerem uma complementaridade entre a qualidade e sofisticação das exportações, tendo ambos influência positiva para o desenvolvimento dos países.

Palavras-chave: Exportação. Qualidade. Sofisticação. Correlação das medidas de exportação.

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List of abbreviations

CIA	Central Intelligence Agency
EU	European Union
GDP	Gross Domestic Product
HS	Harmonized System
ITC	International Trade Centre
OLS	Ordinary Least Squares
GDPPC	Gross Domestic Product per capita
PIB	Produto Interno Bruto
UV	Unit Value
US	United States
WCO	World Customs Organization
WDI	World Development Indicators

1. Introduction

Over the last 20 years the elimination of trade barriers, the integration of markets and globalisation, along with the radical evolution of technology, communication and transportation had an extremely important effect on world trade.

Since the 1980s, the wave of globalisation has seen the significant integration of the world economy. Global trade has increased rapidly during this period (Zhu *et al.* 2010). Therefore, research on international trade grows in relevance and gains an increasing audience every day.

Considering two very important export evaluative criteria – quality and sophistication – reveals itself to be a demanding and difficult task, but at the same time, ambitious and rewarding work, aiming to contribute to the investigation of international trade through a quantitative study of global exports.

Several authors' present recent studies about export sophistication - Lall, Weiss and Zhang (2006), and Hausmann, Hwang and Rodrik (2007) - given its clear relevance at intra-industrial level, as well as at inter-industrial level and between the industries of different countries. The sophistication of exports portrays, on a comparative level, the higher or lower relative position in the value chain of different products.

Furthermore, export quality is a subject which has been studied by a wide array of scholars including Hallak and Schott (2011), and Henn, Papageorgiou and Spatafora (2013), due to the fact that it is also a topic of significant interest for international trade. Quality portrays, in a simplified way, the value differences between products in the same category; for example, a footwear product produced in China at reduced cost and quality, compared to a similar product produced in France, which costs several times more, with almost incomparable quality.

Using data from the International Trade Centre (ITC), the income level associated with 6049 products categories is calculated and later one computes the productivity level associated with a country's export basket for 217 countries over the globe.

The main purpose of this research is to combine these two measures of classifying exports, with the aim of finding new trends, patterns and similarities in international trade, as well as finding answers and possible solutions for these same trends and economic phenomena. To achieve this goal, econometric models are used, including regression analyses.

At the beginning of this research some questions have been explored, which one will attempt to answer during this study. Interesting and, to some extent, surprising results originated, which lead to the main conclusions of the current analysis.

1.1. Rationale of research

The sophistication level of a country's exports is an important evaluator of its trade balance. However, this indicator does not assess the quality of these exports, and quality is another indicator of high significance on the exports basket. This research aims to combine these two measures and establish more logical patterns in the country's trade balance. Sophistication is an across-product measure, which assesses the structure of the exports basket while quality is a within-product measure, which implies a relative specialisation of each product category.

There are other important criteria, like price and quantity. However, as Benkovskis and Rimgailaite (2011) argue, these are not the only important characteristics of international trade. These authors, among others, point out the relevance of variety on a new European Union (EU), but also the quality importance, stating that a large part of the increase in the prices of exports resulted from improving quality, and did not result in a loss of competitiveness.

The choice of sophistication and quality rather than other important criteria mentioned above, beyond the perceived importance of these two measures, has to do with the correlation between both. Furthermore, the real belief of a positive contribution for the exports theory through this methodology, and the certainty to be enriching and rewarding for the researcher, for instance, through an incentive large exports database, emerges as the main choice reasons.

Additionally, as far as the author knows, the methodology of this research has not yet been used in literature in this specific way, crossing these two measures through the calculations discussed below, which provides academic significance to the current study. There are a few studies using the calculation for export sophistication (constructed by Hausmann, Hwang and Rodrik (2007)), but none of them compare it with export quality data using the unit value measure. It is quite relevant to study global exports given its determinacy for the international trade and for the theories of international business.

Relating the literature, the objective of this work is to attempt to answer the following research questions:

1. Which strategy is more successful between quality improvement and climbing the sophistication ladder? Are they complementary or substitutes?
2. In each case, what measure should the countries give greater efforts to in the coming years, given the past experience?
3. What is the correlation between export quality and export sophistication?

1.2. The project description

This project proves itself challenging and ambitious given the wide range of data, but not always comparable to high research standards, in most of the countries across the globe. Knowing the difficulties that will arise during this work from the start, the perseverance and motivation, which stems from the desire to contribute positively to the research on international trade, overlaps.

In the following chapters, we will undertake a review of the literature, explain the calculations, the data collection, the software tools and statistical methods used in the project. As stated above, this research aims to contribute to the international trade theories through a study on exports at a global level, by analysing the quality and sophistication of exports from several countries.

By combining these two export evaluations, it will be possible to find export patterns for several countries from different regions or at different development levels.

Together with the discussion of the key literature in the field, we will provide quantitative research by constructing a database on exports using statistical methods to uncover the correlation between exports quality and sophistication data. We will also present pertinent econometric analyses with relevant statistical tests.

In the last phase, we will discuss some possible explanations for the results obtained by highlighting the most significant and the most surprising results, as well as suggestions for further research.

2. State of the art

With liberalisation and globalisation, the pattern and evolution of exports is attracting greater interest in developing countries (Lall, Weiss and Zhang, 2006) and the structural changes and global growth of exports reveals itself to be an increasingly global concern and critical to many countries.

According to Joshi (2005), the term export means shipping the goods and services out of the port of a country. The seller of such goods and services is referred to as an exporter and is based in the country of export, whereas the overseas-based buyer is referred to as an importer. In international trade, exports refer to selling goods and services produced in the home country to other markets.

A country's geography is a relevant influence on exports (Bernard, *et al.* 2007), with distance being an important factor to take into account. For example, it impacts on a country's export basket or on the number of countries with which the companies trade, having a high influence on exports globally and, in some cases, leading to a firms' reallocation.

Greater trade openness raises industry productivity via a selection effect (lowering the maximum marginal cost of active firms) and via a production reallocation effect (production shifts to the most productive firms) (Baldwin and Robert-Nicoud, 2004). The exposure to trade will only induce the more productive firms to enter the export market, while some less productive firms continue to produce only for the domestic market, and will simultaneously force the least productive firms to exit (Melitz, 2003). Aggregate reallocation made a larger contribution to growth than aggregate technical efficiency, suggesting that movement of inputs to more highly valued activities on average plays a stabilising role in manufacturing growth (Petrin, White and Reiter, 2011).

In their study on China, Gao, Whalley and Ren (2014) decomposed the country's export growth into three parts: extensive margin, increased quantity and increased prices. It was concluded that China's export growth depends more on price increases and less on quantity expansion. The extensive margin, defined as the growth of exports due to change in varieties, plays the least important role out of the three parts. The authors' explanation for these three factors is that the contribution of price will probably increase gradually, because of the improvement in the commodities' quality, while the quantity will probably decrease because of a rising labour cost. A note should be highlighted. One possible explanation for why variety

plays the least important role may arise from data aggregation, which limits the analysis and may lead to underestimation of its contribution.

Using 1995 trade data, Hummels and Klenow (2002) showed that the extensive margin (variety), accounts for two-thirds of the increase in exports of larger economies, and one-third of the increase in imports of larger economies. Price and quantity decompositions indicate that richer countries export more units at higher prices, and their estimates imply that quality differences could be the proximate cause for about 25 percent of a country's differences in real income per worker.

The aforementioned authors present some additional significant considerations, like the positive correlation between the exports' variety and the country's size, and also the importance of the quality differentiation for trade models and export growth. They also find that larger economies export more in absolute terms than smaller economies and that within categories, richer countries export more units at higher prices to a given market, which is consistent with producing higher quality. Their estimates imply that quality differences could be a proximate cause of around 9 percent of country's differences in real income per worker.

Feenstra *et al.* (1999) and Feenstra and Kee (2008) tested the exports variety on the productivity and the endogenous growth of the countries and found a positive correlation between these variables. Therefore, the variety is an important criterion of export classification, as well as other extremely important criteria widely studied in modern theories of international trade, such as, quantity, quality and sophistication.

It is widely believed that technology-intensive exports imply greater development benefits to exporting countries (Lall, Weiss and Zhang, 2006). These authors proposed a new classification for the division of traded categories of products called "sophistication" to measure the product characteristics based on the average income of exporting economies. The authors argue that an export is more sophisticated the higher the average income of its exporter is. Their classification integrates not only technology, as the most important factor, but also other significant factors, including marketing, logistics, proximity and infrastructure.

According to Khandelwal (2010), the potential for quality upgrading varies by product and tends to be higher in manufactures than in agriculture and natural resources. This explanation could be the reason why some countries, at an early stage of development, change their production to more sophisticated goods as a precondition to reaping large gains from quality improvement (Henn, Papageorgiou and Spatafora, 2013).

In a study on US imports by Schott (2004), these findings have already been mentioned, since, according to the author's results, the manufactured goods exhibit a significant relationship between unit value and the Gross Domestic Product per capita (GDPPC) in favour of within-product specialisation, whereas the results were not favourable to across-product specialisation.

Lall (2000) argues that low-technology products have the least beneficial spillover effects on the economy and that it tends to grow slower. The author argues that export structures, being path-dependent and difficult to change, have important implications for growth and development and that the technology-intensive products have the most beneficial effects, growing faster in the world trade.

The aforementioned author defends that a set of few countries are succeeding in their export performance, with rapidly expanding export earnings and increasing quality, with many countries stagnating in terms of both export earnings and quality. Countries 'in the middle' present reasonable rates of quantity growth but relatively weak improvements in quality.

The technological spillovers between industries are mentioned by various authors as Nadiri (1993), who states that the diffusion of new technologies is considerable and their effects on productivity growth are sizable. Technological products therefore, in general the most expensive ones, are where countries should invest. As Hausmann and Klinger (2006) say, rich countries produce more output per worker but also more challenging products, the "rich-country" goods.

> "Economies grow by upgrading the type of products they produce and export, the technology, capital, institutions and skills needed to make such new products are more easily adapted from some products than others." (Hidalgo *et al.* 2007)

Table 1 – Related literature studies

Author's	Covering years	Analysed countries	Main results
Nadiri (1993)			Technological Spillovers
Feenstra et al. (1999)	1975-1991	South Korea and Taiwan	Exports variety and endogenous growth
Lall (2000)	1985-1998	Developing countries	Exports manufactured patterns
Melitz (2003)			The impact of trade on firms' reallocations
Baldwin & Robert-Nicoud (2004)			The impact of trade on firms' reallocations (A comment to Melitz (2003) work)
Schott (2004)	1972-1994	136 US importers	Quality and sophistication specialisation
Hummels & Klenow (2005)	1995	126 countries	The variety and quality of exports
Hausmann & Klinger (2006)	1962-2000		Structural transformation and patterns of comparative advantage
Lall, Weiss & Zhang (2006)	1990 and 2000		New measure of products characteristics
Rodrik (2006)	1999-2001	China	China exports sophistication
Bernard *et al.* (2007)	1992-2000	US	Firms in international trade
Hausmann, Hwang & Rodrik (2007)	1999-2001	124 countries	Sophistication formulas developers (PRODY and EXPY)
Hausmann & Klinger (2007)	1975-2005	Chile	Chile structural transformation using exports sophistication
Hidalgo et al. (2007)			Product space and development
Kumakura (2007)		China	China exports sophistication
Feenstra & Kee (2008)	1980-2000	48 countries	Export variety and country productivity
Schott (2008)	1972-2001	China	China exports sophistication
Vitola & Davidsons (2008)	1996 and 2005	95 countries	Structural transformation of exports
Bastos & Silva (2010)	2005	Portugal	Export quality
Cabral & Veiga (2010)	1960-2005	48 Sub-Saharan African countries	Export diversification and sophistication

Hausmann & Klinger (2010)	1985-2007	Ecuador	Ecuador structural transformation using exports sophistication
Khandelwal (2010)	1989-2001	US importers	Quality ladders of US imports
Mandel (2010)	1994-2006	US importers	Heterogeneous Firms and Import Quality
Minondo (2010)	1999-2001	113 countries	Exports quality and productivity
Xu (2010)		China	China exports sophistication
Zhu et al. (2010)	1992-2006	171 countries	Export sophistication drivers
Baldwin & Harrigan (2011)	2005	228 US exporters	Export quality
Benkovskis & Rimgailaite (2011).	1999-2009	10 EU new member states	Quality and variety of EU new member states
Hallak & Schott (2011)	1989-2003	43 US trading partners	Differences in product quality
Mishra, Lundstrom & Anand (2011)	1990-2007	103 countries	Service export sophistication
Petrin, White & Reiter (2011)	1976-1996	US	Reallocations and technical progress
Sutton & Trefler (2011)	1980 and 2005	94 countries	Quality and GDP per capita on export basket
Jarreau & Poncet (2012)	1997-2009	China	Export sophistication
Jesus et al. (2012)		124 countries	Product complexity
Johnson (2012)	1985-1995 and 2000	125 countries	Prices and quality of exports
Szcygielski & Grabowski (2012)	1994-2009	183 Germany exporters	Are unit values correct measures of exports quality?
Henn, Papageorgiou & Spatafora (2013)	1962-2010	178 countries	Export quality in developing countries
Jesus et al. (2013)	1962-2006	China	China's sophistication and diversification
Feenstra & Romalis (2014)	1984-2008	200 countries	Export prices and quality
Gao, Whalley & Ren (2014)	1995-2010	35 China's importers	China's export variety, quality and quantity
Vandenbussche (2014)	2005-2011	EU exporting countries	New quality indicator
Gervais (2015)	1972-1997	US	Product quality
Thorbecke & Pai (2015)			East Asian exports sophistication

Source: Own development.

2.1. Export quality measure

The general meaning of quality, can be seen as conformance to requirements, the requirements may not fully represent customer expectations (Crosby, 1979). Drucker (1985) says that quality in a product or service is not what the supplier puts in, it is what the customer gets out and is willing to pay for.

In another view of quality, Walton and Deming (1988) concentrate on the efficient production of the quality that the market expects. Linking quality and management, they say that costs go down while productivity goes up, as improvement of quality is accomplished by better management of design, engineering, testing and by improvement of processes.

According to Vandenbussche (2014), the measure of quality is a difficult task given that quality is an unobserved product characteristic. However, it is assumed that consumers care about price, relative to quality, when choosing between products and quality can be defined as any tangible or intangible attribute of a good that increases all consumers' valuation of it (Hallak and Schott, 2011).

Gervais (2015) said that if the firm invests in an expensive technology and incurs relatively high production costs, consumers classify its output as high quality and as a result, the firm obtains a favourable demand shift and can sell relatively large number of units at a given price.

The quality of traded goods receives less attention than it deserves. In 2006 the global exports of goods and services was 11627,5 billion US dollars at the 2000 constant price, which is 4.6 times of that in 1980 at 2520.2 billion US dollars, and 2.8 times of that in 1990 at 4138.9 billion US dollars, giving quality great influence in this evolution. (Zhu et al. 2010).

Henn, Papageorgiou and Spatafora (2013) achieved some relevant conclusions about the importance of quality on exports. They argued that within any given product line, quality converges both conditionally and unconditionally to the world frontier and also that increases to institutional quality and human capital are associated with faster quality upgrading and, in turn, faster growth in quality is associated with a more rapid output growth. The concepts of quality and sophistication are quite different and its upgrade should be viewed as complementary.

Prices contain information about differences in product quality and contain valuable information to refine our understanding of the causes of trade. They provide evidence about the

extent of vertical specialisation and quality heterogeneity within sectors and across countries. (Johnson, 2012).

To determine the products quality, a simple calculation will be used: the total price of a product exports (in thousands of dollars) over the exported quantity for the same product (in tons), widely used on the export literature as unit value:

$$u = \frac{V}{Q}$$

It has become common to measure the quality of exports using their unit value (UV) and is also frequently used to measure quality in empirical research. Nonetheless, this measure has been the subject of several criticisms, mainly due to the determination of their components. For instance, prices might not follow quality closely, if goods are differentiated not only by quality but also by other factors (e.g., due to horizontal product differentiation). Also export prices might reflect international trade costs (Szcygielski and Grabowski, 2012).

Feenstra and Romalis (2014) claim that the unit values of internationally traded goods are heavily influenced by quality. The observed differences in export unit values are attributed predominantly to quality, with very small remaining difference in quality-adjusted export prices and they also find a greater preference for quality in richer countries. Once again the prices of the unit values are related with quality and many authors use this proxy stating to it as the exports quality. Models with quality choice by heterogeneous firms include Gervias (2010) and Mandel (2010).

Hallak and Schott (2011) argue that consumers are assumed to care about the price relative to quality in choosing among products, but that two countries with the same export prices but different global trade balances must have products with different levels of quality, suggesting that among countries with identical export prices, the country with the higher trade balance is revealed to possess higher product quality.

Unit values increase systematically with distance, and tend to be higher in shipments to richer nations - Bastos and Silva (2010) - and within products the unit values tend to increase with the size of the destination market. To estimate the drivers of export unit values they estimate a linear regression of the unit value prices with econometric methods and the results converge to the Baldwin and Harrigan (2011) findings based on product-country data relating to distance unit value differences.

The average unit value of exports is positively related to distance, Baldwin and Harrigan (2011) assume that consumers care about quality and firms' heterogeneity in productivity shows up in heterogeneous quality in a specific way. The most competitive firms' charge the highest market prices and the most expensive products seem to be sold to the most distant markets.

Some authors' attempt to find a more consensual and efficient method for the quality measurement like Hallak and Schott (2011) or Henn, Papageorgiou and Spatafora (2013), however, these new methods are still not sufficiently tested. The same happens with other alternative quality measurement, fairly appreciated, as the Khandelwal (2010) approach and more recently the Vandenbussche (2014) through a new quality metric method.

Khandelwal (2010) proxies' quality by a variety-fixed effect to capture the time-invariant part of quality combined with time-fixed effect to account for the variation of quality over time, arguing that he has a model where quality can only increase as a result of marginal cost and therefore he does not need to disentangle quality from marginal cost since both always move in the same direction and that, conditioning on price, products with a larger market share, must have a higher quality.

Quality ladders are useful since they give information about the extent of product differentiation in a particular product market. A short quality ladder implies that all products are close substitutes and there is not much possibility for differentiation, while a longer quality ladder suggests that consumers appreciate product differentiation and are willing to pay for it. (Vandenbussche, 2014).

Regardless some valuable alternative approaches for the export quality measure, they are not considered the most appropriate for this research, taking into account the size of the database and the flexibility to work with the data from the two measures. Thus, unit value will be used for quality proxy, presupposing that it will be the most suitable for this research rather than others.

2.2. Export sophistication measure

In common language, the term sophistication is associated with complexity, development, progression or advancement. Concerning international trade, export sophistication is a relatively recent concept that, as mentioned above, corresponds to the value differences between products in different categories, as Schott (2004) says is an across-product classification.

Following Jesus et al. (2012), the products complexity is related with the income level of the countries, the high-income countries being the major exporters of more complex products. The authors explain that product complexity refers to the ubiquity of a product, that is, the number of countries that export the product with comparative advantage. Hidalgo et al. (2007) also said that economies grow by upgrading the products they produce as a process of learning how to produce more complex products. They argue that the varieties and quality ladders models assume a continuum of products, so there is always a slightly more advanced product that countries can move to, abstracting away similarities between products when thinking about structural transformation and growth.

Returning to Lall, Weiss and Zhang's (2006) work, they found no statistically discernible relationship between export growth rates and sophistication. They claim that a rise in product sophistication may be desirable in terms of entering higher value processes and products, but that this applies within given activities or products and so, when considered across-products, there is no effect of a rise in sophistication on export growth.

Could this fact really be true? And if so, what drives some countries to expand the range of their exports towards more sophisticated goods and yet specialise in low-quality varieties? (Hausmann, Hwang and Rodrik, 2007).

Developing this research question, Sutton and Trefler (2011) found that between 1980 and 2005, low-income countries had moved into producing more sophisticated products, producing, however, low-quality or low-end products within these industries and, as a result, this diversification has not led to a big boost in the per capita GDP. They argue that as the country advances into the production of higher-ranked products, the rise in wage causes its effective cost level to rise, and its global market share in this industry to fall.

Rodrik (2006) implicitly assumed that low-quality high-category goods are better for economic growth than high-quality low-category goods. In their study on China's exports

sophistication, he argued that China has ended up with an export basket that is significantly more sophisticated than what would be normally expected, having government policies helped nurture domestic capabilities in consumer electronics and other advanced areas that would most likely not have developed in their absence. Kumakura (2007) identifies several problems about the export sophistication index employed in Rodrik's work, developed in Hausmann, Hwang and Rodrik (2007), arguing that this index has several technical and other weaknesses that can impart an inappropriate policy implication because the value of this index is influenced heavily by factors unrelated to technology and policy and is not appropriate when it is used to assess the relationship between export structure and economic growth.

Following Jesus et al. (2013) the key factor underlying the intriguing China's fast development during the last 50 years is its ability to master and accumulate new and more complex capabilities, reflected in the increase in diversification and sophistication of its export basket.

In a study about Sub-Saharan Africa countries, relating the sophistication and the diversification, Cabral and Veiga (2010) present some political and economic factors that determine the success of these strategies for this group of countries. Using separate regressions for each measure, they find a positive correlation between the sophistication and diversification for the success of the countries development variables including growth stability, infant mortality and life expectancy. Relating the GDP growth, the authors found a positive relation between exports diversification and exports sophistication but this relationship was not robust.

Zhu et al. (2010) suggest that the export sophistication of countries is enhanced by capital intensity and engagement in knowledge creation and transfer via investment in education, R&D, foreign direct investment and imports.

> "It is essential for the improvement of a nation's welfare, as observations show that in a longer perspective the level of economic development is related to the degree of export sophistication. The speed of structural transformation depends on the distance in the product space between the potential export goods and the existing export goods with revealed comparative advantage." (Vitola and Davidsons, 2008).

Hausmann, Hwang and Rodrik (2007) constructed an index of the "income level of a country's exports", and showed that it predicts subsequent economic growth. For that, they

developed a model to find a function of the productivity level associated with a country's export basket, nominated as EXPY, equals:

$$EXPY_i = \sum_l \left(\frac{x_{ij}}{X_i}\right) PRODY_l$$

Determinate through an index they called PRODY that it´s a weighted average of the per capita GDP's (GDPPC) of countries exporting a given product, and representing the income level associated with that product, equals:

$$PRODY_k = \sum_j \frac{(x_{jk}/X_j)}{\sum_j (x_{jk}/X_j)} Y_j$$

These formulas were the basis for this work. They allowed us to calculate the income level of the products that may be greater, even if its manufacturing level is lower, for example, it can yield more to produce an Agricola good than a technological one. To better understand the concrete results of this work, we have to expand the meaning of these formulas.

At the product level, by calculating the PRODY, relevant information was obtained individually, for each category of products with higher income levels, i.e. indicate what the countries should or not produce. Being however an average total set of all the countries, which means that it may not be true for a specific country to produce some product with a higher global income, meaning that each country should always take into account all the specific variables of each product as well as the variables of their own country's specific conditions such as, political factors, export barriers and production conditions for these products among others.

On the other hand, at the country level (using the EXPY), the results show the level of productivity of a country's exports basket which means, in other words, that it reveals an analysis of its international trade, the exports evaluation of each country individually. With this information, a country can observe where it can improve, what it is producing and exporting with lower productivity and obtain some positive and negative historical examples from other countries.

As Minondo (2010) discusses, a limitation of the PRODY, and hence the EXPY index, is that it does not correct the differences in quality within a product category, for example, using

exports' unit value as a proxy. This author uses three quality ranges, for each commodity, based on the unit values of the countries that export that commodity, low quality, medium quality and high quality and they show, that if products are distinguished by its quality level there is no longer a robust relationship between specialising in products associated with higher productivity levels and faster growth.

The aforementioned author, argues that their alternative economic mechanism is related to a country's quality upgrading frontier and shows that, countries that start producing low-quality products grow faster than countries producing closer to the quality frontier, and this convergence process occurs because countries specialised in the low-quality ranges have more room to improve productivity than those specialised in the high-quality ranges.

Using a similar methodology of this work for the sophistication measure of exports, PRODY for the products income and the EXPY for countries productivity, detailed in chapter 3, several authors presented many significant conclusions about a country's sophistication as Cabral and Veiga (2010). These formulas allow us to analyse a single country's sophistication like Hausmann and Klinger (2007) and (2009) made for Chile and for Ecuador with implications for this country's structural transformation.

Jarreau and Poncet (2012) find evidence in support of regions specialising in more sophisticated goods subsequently grow faster in regions from China. For China and Asia studies, these formulas following Hausmann, Hwang and Rodrik (2007) work, originated several analyses like Thorbecke and Pai (2015) and Schott (2008) that question China's ladder sophistication. Schott (2008) also questions if the price of a developing country's export reflects its ability to produce a given level of quality, or if that country's quality is a weighted average of inputs potentially sourced from developed economies.

Jarreau and Poncet (2012) confirm Hausmann, Hwang and Rodrik (2007) prediction that regions that specialise in more sophisticated goods subsequently grow faster stating that there is a substantial variation in export sophistication controlling for the level of development, and that this difference in turn matters for growth but they also found that growth gains from improved technological capabilities only occur when these capabilities are developed by domestic-owned firms and embedded in ordinary trade.

China's sophistication has been a well-studied topic, the recent studies found that China is exporting highly sophisticated goods that are not comparable with its income level. Xu (2010) have questioned this fact arguing that product quality has not been fully accounted for in this

observation, causing an overestimation of the sophistication of China's exports. This author also reflects on the average income used in the sophistication measurement causing an underestimation of China's capability of exporting sophisticated goods.

This sophistication proxy for services was used by Mishra, Lundstrom and Anand (2012) which positively related the association between economic growth and the sophistication of services on exports. They argue that including services in growth considerations does not imply neglecting manufacturing exports and its benefits but that services can be an additional channel for promoting high growth.

Despite some author's individual analyses, this study does not focus on a specific country but rather on the overall performance of many countries being a global survey to assess the correlation between exports sophistication and quality on the countries development.

3. Research design

This chapter features the type of research and methodology. The data collection is presented, the calculations explained and the method that was used in this work, showing that this research aims to contribute to the international trade theories through a study at a global level by analysing the exports quality and sophistication from the countries worldwide.

3.1. Type of research

According to Arnal, Rincón and Latorre (1992) the term science is associated with a rigorous, methodical and systematic knowledge form, that seeks to optimise the available information regarding the problems of theoretical and/or practice origin, whose primary function is the understanding, explanation, prediction and control of the events.

The essential purpose of this research is to increase personal and scientific knowledge on the topic. To this end, essentially quantitative research was conducted, although with qualitative analysis on the results.

The research type is descriptive, relating the phenomena as they exist, identifying variables and inventorying facts and using statistical techniques for summarising the information, and also a correlational research, relating the variables effects, assessing interactions and differentiating groups (Barañano, 2008).

3.2. Details of data

The first step accomplished, before the collecting of data, was to investigate all the formulas used on the proxy for the sophistication and for the quality, in order to assess their feasibility and verify all the necessary requirements for its determination and aiming to find all the necessary data required for the next stage of the data collection.

The data was collected directly from online databases, downloading the files, one by one, mainly through the International Trade Centre (ITC), exported in Microsoft Office Excel spreadsheet format. It was necessary to export the files with the export value and the unit value data of 6049 product categories, totalling more than 12.000 downloads. These products correspond at the 6-digit level of the Harmonized System, the most significant classification system for the products, using the latest revision (HS Revision 2012).

The Harmonized System (HS) is an international nomenclature defined by the World Customs Organisation (WCO) for the products classification. It allows participating countries to classify traded goods on a common basis for customs purposes. At the international level, the Harmonized System for classifying goods is a six-digit code system.

The HS comprises presently more than 6000 article/product descriptions, on the set of all the revisions, that appear as headings and subheadings, arranged in 96 chapters of product categories, and more 3 special chapters wherein only one is utilised in this work (99 - Commodities not elsewhere specified), on a total of 97 chapters of products categories, the other two special chapters being excluded (Chapter 77 is reserved for future international use only and chapter 98 comprises special classification provisions).

The six digits of a product code can be interpreted by groups of two digits. The first two digits (HS-2) identify the chapter the good is classified in, e.g. "09 = Coffee, tea, mate and spices". The next two digits (HS-4) identify groupings within that chapter, e.g. "0902 = Tea, whether or not flavoured". The next two digits (HS-6) are even more specific, e.g. "090210 = Green tea (not fermented)" (International Trade Centre (ITC)).

All the products into the HS system can be classified by one logical interpretation according to their form and function, following also an increasing order of complexity, being ordered progressively by their characteristics, following the general rules of interpretation of the internationally standardised system of names and numbers to classify traded products developed by the World Customs Organization (WCO). These rules apply to all products. Any product for which there is no current classification can be listed under "Other" classification.

As explained above, for calculating the exports sophistication and quality the HS-6 at the 6 digits' level was used, working with 6049 different products, a disaggregated data.

The population of this research was composed by 217 countries. It was decided to have a large number of countries because the author considered that being a quantitative analysis, even if it takes some more time, it would be positive to include almost all the existing countries in the globe. All the countries belong to The World Factbook of the Central Intelligence Agency (CIA) of the United States online database.

Finally, the search is performed for 14 years (from 2001 to 2014), using all the available years in the ITC, which gives a wide and current time period, giving value to the research and an advantage over less current studies.

The other variables included on this research were exported through the World Bank's World Development Indicators (WDI), except the variable "Mean years of schooling" exported through the International Human Development Indicators from the United Nations Development Programme.

3.3. Research method

After the data collection, Microsoft Office Access was used to aggregate all the files to work with one single file with all the required data. This program made it possible to do the calculations with all the necessary data. The formulas for the exports sophistication were as aforementioned, developed by Hausmann, Hwang and Rodrik (2007):

$$PRODY_k = \sum_i \frac{(x_{ik}/X_i)}{\sum_j (x_{ik}/X_i)} Y_i$$

The Sum of *i* countries exporting *k* products, of the division of the numerator, that is the weight of the country *i* to export *k* on the total exports on the denominator, which is the Sum of the weight of all countries exporting *k*, multiplied by Y*i* the per capita GDP of the country *i*.

Having the PRODY calculation for the 6049 products it was possible to calculate the country's EXPY using the formula:

$$EXPY_i = \sum_k \left(\frac{x_{ik}}{X_i}\right) PRODY_k$$

The Sum of *k* products, of the division of the weight of the product *k* on the country *i* on the total of its exports, multiplied by the PRODY of *k*.

On the quality side, a simple mean was used of the unit value by the country *i* on the year *j* equals:

$$\overline{UV}_{ij}$$

After these calculations, we have the sophistication and the quality variables aggregated for the group of 217 countries for the 14 years.

During the research, great limitations of the quality measure by the unit values were found. Being the unit value the price of different products exported by a country, the variable will not be a good measure of quality, only representing the type of products (with high or low prices) of the country's exports basket, for example a country that exports mainly expensive products like diamonds will have high unit values but does not mean that this country is exporting with high quality.

Attempting to solve these imitations, the author developed a new quality measure named QUALY based on a unit value ratio through the formula:

$$QUALY = \sum_{k} \frac{uv_{ik}}{\overline{uv}_{k}} \cdot \frac{x_{ik}}{X_{i}}$$

$\frac{x_{ik}}{X_i}$ = weight of the product *k* on the country *i* total exports

$\frac{uv_{ik}}{\overline{uv}_{k}}$ = quality ratio of the country *i* on the product *k*

uv_{ik} = unit value of the country *i* on the product *k*

$\overline{uv}_{k}$ = unit value mean of the product *k* equals:

$$\sum_{i} uv_{ik} \frac{x_{ik}}{X_{k}}$$

$\frac{x_{ik}}{X_k}$ = weight of the country *i* on the product *k* total exports

x_{ik} = exported value of the country *i* on the product *k*

X_k = total export value of the product *k*

This new variable, the QUALY, was added to the model. However, it is only a comparative variable to observe the differences, the unit value remaining the main quality indicator of this work although its' observed limitations.

Aiming to assess the relevance of the measures for the country's development, some relevant and appropriate variables were added to complement the econometric model. The variables are economic indicators of the countries development and the baseline model follow the economic growth model of Aisen and Veiga (2013), some additional explanatory variables

common to other economic development regressions found in the literature were added (see table 8 in appendices). The variables included in the econometric model are the following:

- Per capita GDP (constant 2005 US$) (GDPPC): GDP per capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products.
- General government final consumption expenditure (% of GDP) (GOV): General government final consumption expenditure (formerly general government consumption) includes all government current expenditures for purchases of goods and services (including compensation of employees). It also includes most expenditures on national defence and security, but excludes government military expenditures that are part of government capital formation. General government usually refers to local, regional and central governments.
- Expenditure on education as percentage of total government expenditure (%) (EDUC): General government expenditure on education (current, capital, and transfers) is expressed as a percentage of total general government expenditure on all sectors (including health, education, social services, etc.). It includes expenditure funded by transfers from international sources to government.
- Gross capital formation (% of GDP) (INVEST): Gross domestic product (GDP) from the expenditure side is made up of household final consumption expenditure, general government final consumption expenditure, gross capital formation (private and public investment in fixed assets, changes in inventories, and net acquisitions of valuables), and net exports (exports minus imports) of goods and services. Such expenditures are recorded in purchaser prices and include net taxes on products.
- Inflation, GDP deflator (annual %) (INFL): Inflation as measured by the annual growth rate of the GDP implicit deflator shows the rate of price change in the economy as a whole. The GDP implicit deflator is the ratio of GDP in current local currency to GDP in constant local currency.
- Population growth (annual %) (POPG): Annual population growth rate for year t is the exponential rate of growth of midyear population from year t-1 to t, expressed as a percentage.

- Trade (% of GDP) (TRADE): Trade is the sum of exports and imports of goods and services measured as a share of gross domestic product.
- Labour force (total) (LABOUR): Total labour force comprises people ages 15 and older who meet the International Labour Organization definition of the economically active population: all people who supply labour for the production of goods and services during a specified period.
- Mean years of schooling (of adults) (years) (AVERAGE_EDUC): Average number of years of education received by people ages 25 and older, converted from education attainment levels using official durations of each level.

The econometric model was developed to explain the countries development through the dependent variable GDPPC, being the exports sophistication (EXPY) and the exports quality (Unit value and QUALY) and the remaining economic indicators the explanatory variables through the model:

EQUATION 1: $lnGDPPC = \beta_0 + \beta_1 lnEXPY_i + \beta_2 ln\overline{UV}_i + \beta_3 lnQUALY + \beta_4 GOV + \beta_5 lnEDUC + \beta_6 lnINVEST + \beta_7 INFL + \beta_8 POPG + \beta_9 TRADE + \beta_{10} lnLABOR + \beta_{11} AVERAGE\_EDUC + u_i$

To compare the effects with the Aisen and Veiga (2013) model of economic growth the second regression was created by changing the dependent variable to the growth of the GDPPC, used on the authors model, enabling comparisons between the results and providing additional information concerning the two different regressions, given by the general form:

EQUATION 2: $lnGDPPCgrowth = \beta_0 + \beta_1 lnEXPY_i + \beta_2 ln\overline{UV}_i + \beta_3 lnQUALY + \beta_4 GOV + \beta_5 lnEDUC + \beta_6 lnINVEST + \beta_7 INFL + \beta_8 POPG + \beta_9 TRADE + \beta_{10} lnLABOR + \beta_{11} AVERAGE\_EDUC + u_i$

In both models 'u_i' is a white noise error term. These regressions and data analysis are made with the help of the statistical software program STATA, being all the data indicators exported to the integrated statistics program to be analysed. It is expected to accomplish the desired results to reply to the initial research questions, analysing the data in detail in chapter 4 of data analyses and results.

3.4. Econometric methods

Econometrics is based upon the development of statistical methods for estimating economic relationships, testing economic theories, and evaluating and implementing business policy and to predict economic time series. (Wooldridge, 2004).

Given a random sample, the method of ordinary least squares is used to estimate the slope and intercept parameters in the population model. To attain the desired results, the OLS model seems appropriate because it provides the necessary correlation results to reply to the starting research questions.

The name "ordinary least squares" comes from the fact that these estimates minimise the sum of squared residuals. With OLS, it possible to derive unbiasedness, consistency, and other important statistical properties relatively easily. OLS is appropriate for estimating the parameters appearing in the conditional mean function.

Two important issues in applied economics are understanding how change the units of measurement of the dependent and/or independent variables affects OLS estimates and knowing how to incorporate popular functional forms used in economics into regression analysis. OLS estimates change in entirely expected ways when the units of measurement of the dependent and independent variables change.

The mechanics of simple regression do not depend on how y and x are defined, the interpretation of the coefficients does depend on their definitions. For successful empirical work, it is much more important to become proficient at interpreting coefficients than to become efficient at computing formulas.

Multiple regression analysis is more amenable to ceteris paribus analysis because it allows us to explicitly control for many other factors that simultaneously affect the dependent variable. This is important for testing economic theories because multiple regression models can accommodate many explanatory variables that may be correlated.

The multiple regression model allows us to effectively hold other factors fixed while examining the effects of a particular variable on the dependent variable. It explicitly allows the independent variables to be correlated. Although the model is linear in its parameters, it can be used to model nonlinear relationships by appropriately choosing the dependent and independent variables.

The method of ordinary least squares is easily applied to estimate the multiple regression model. Each slope estimate measures the partial effect of the corresponding independent variable on the dependent variable, holding all other independent variables fixed.

The regression analysis is appropriate for the necessary correlations of this study, detailed in the next chapter, to analyse the statistical influence and relevance of the exports quality and sophistication, as explanatory variables of the country's production and development.

4. Data analyses and results

With no surprise, the countries that appear on the top list with the highest sophistication indices (EXPY) are also countries at the top of the world development and/or economic power (see the full list in the table 6 in appendices).

Looking into the ranking top 5, it has Luxembourg, Ireland, Switzerland, Finland and Andorra, which are recognised for their high development. Therefore, it's not surprising that they also appear leading the sophistication ranking, revealing an association between their good export practices and their development.

The EXPY value means the productivity level associated with the country's export basket, the country's sophistication, so the products included on the country's export basket will influence all the EXPY results. Accordingly, it's expected that countries like Luxembourg and Ireland, the highest ranked countries, are exporting products with a higher income level associated. Other reasons related with these results are for example some fiscal advantages of these countries and also their high GDPPC being the Luxembourg the country with the highest value in this indicator in the sample.

The relevance of the country's export basket also helps to explain some surprising ratings, as the USA ranked in 15th with a relatively low result of 16.508 (thousand dollars) compared with their high development, being the country exporting some products with a lower associated income level. The EXPY mean value for all the countries is 9,174 (thousand dollars) and Portugal ascend in 35th position with a good result of 13,501 (thousand dollars) having exported some goods with a high-income level. At the bottom of the ranking are countries like Nepal, Ethiopia or Papua New Guinea, with no surprise, being some of the world less developed countries and also with very low GDPPC.

In terms of quality (see table 7 in appendices), there are some surprising countries on the top of the list, like African countries such Angola or Namibia. This reason appears to relate the high prices of some products exported by these countries, such as minerals like precious stones, influencing the unit value results, distorting the quality measurement. This is a problem of the quality measurement through the unit value reflecting some high prices that are not related with quality but with the product characteristics like the unit value of gold. Consequently, countries that mainly export these type of extremely high value products rise

fairly in the rank such as Myanmar, one of the poorest countries in the world, being the 55th on the quality rank.

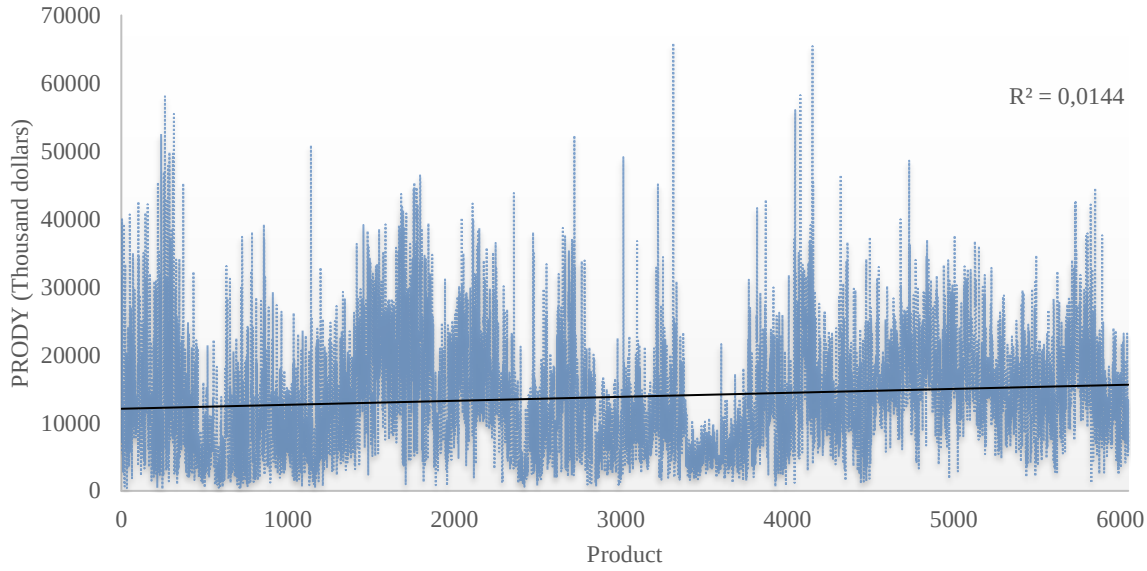
Leading this proxy are the Netherlands and the Switzerland, the quality leaders, both countries being some of the best examples on development and richness. At the bottom of the list are Sao Tome and Principe and Gambia, not surprising, less developed countries. The results converge to Hausmann and Klinger (2006) and Feenstra and Romalis (2014) argument, that rich countries produce more challenging products.

In the following graph 1, are the obtained results for the products sophistication (PRODY). We can see that, although existing a small growing trend, there is no statistical correlation with the gradual increase of products by category. The products in the HS system are classified following an increasing order of complexity by their characteristics', meaning that a stronger correlation was expected to exist and a much higher PRODY for the products in higher categories which does not exist.

These results are in disagreement with Hausmann, Hwang and Rodrik (2007) arguing that "items with low PRODY tend to be primary commodities", in fact the graph shows that a higher level of complexity of the product, or a product with highest level of manufacturing, it is not associated with an increase in its income and primary products often have higher productivity levels.

It is possible to note, in table 5 (see appendices), the products with smallest and largest productivity level associated with the sophistication products database with 6049 products. It is true that at the bottom are primary products, but it is also true that at the top of the list are also some primary products in low categories like some food products as the "030615 Frozen Norway lobsters", exported by countries with high GDPPC, or the product "030390 Frozen Livers and roes" being possible to observe that is not necessary to belong to a high complexity level to be a high productivity level product.

Graph 1 – Sophistication by product category (PRODY)



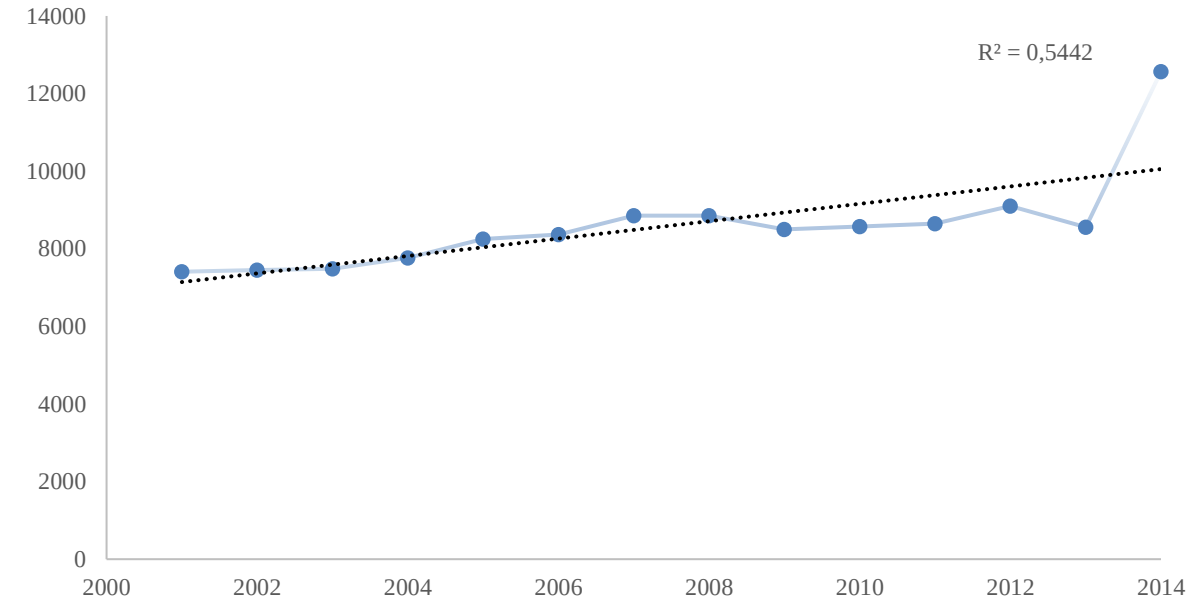
Source: Own computations. Data in US dollar thousands.

The product with the highest classification of the sophistication rank it's the "590290 Tire cord fabric made of viscose rayon high tenacity yarns", a product on the middle of the products categories number 59, this product being mainly exported by Luxembourg, the country with the highest GDPPC.

In the next graph 2, it's possible to discern the countries sophistication during the 14 years, until 2014, as being progressively growing with a rising trend ($R^2 = 0.5442$), meaning a rise in the countries sophistication over this period.

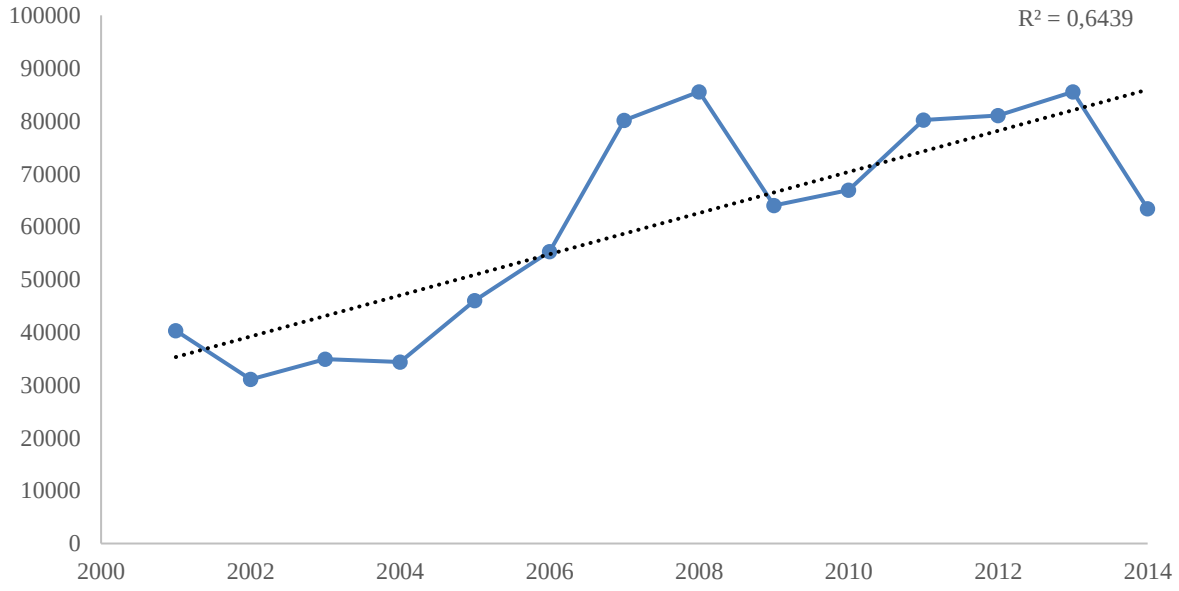
The same happened with the quality for the same period (graph 3), although with a big change after 2008, during the world crisis, with a rising trend, bigger than the sophistication with a $R^2 = 0.6439$. We must see that the prices volatility is greater and more sensitive to economic changes, which explains some unit values and quality results.

Graph 2 – Countries sophistication (EXPY)



Source: Own computations. Values in US dollars.

Graph 3 – Countries quality (unit value)



Source: Own computations. Values in US dollars.

Table 2 reveals the description of all the variables of this research. Note that comma is the thousands separator and dot is the decimal separator. Starting with the EXPY and the unit value it is possible to observe the large differences between the two variables, being the relative values of the unit value considerably higher with a mean of $61,702 while the mean for the

EXPY it is $9,174. It's possible to observe a high standard deviation of the unit value of $175,628 presenting a high data dispersion relative to the mean. The very high maximum result of the unit value is due to the fact of having some outliers with these values.

Concerning the EXPY minimum and maximum values, looking to the EXPY list (table 6 in appendices), it has in the maximum $27,301 for Luxembourg and in the minimum $1,848 for Comoros. Table 2 reveals very different values because of the large countries sample with many outliers, for example a small island for a specific year could have very discrepant results. This outliers' problem is even larger for the unit value sample, as can be seen in the unit value maximum, which can be explained for example by a country exporting mainly diamonds or other extremely valuable products for one specific year will increase widely this result.

Table 2 – Descriptive statistics for the variables

Variables	N	mean	p25	p50	sd	min	max
EXPY	2,939	9,174	5,187	8,438	5,178	513.600	53,005
UNIT VALUE	2,892	61,702	10,241	20,010	175,628	6.000	3.3e+06
QUALY	2,496	2,030	277.800	1,143	2,330	7.41e-05	14,909
GDPPC	2,258	10,811	961.100	3,396	16,030	135.600	86,129
GOV	2,056	16.870	11.870	16.380	9.009	2.047	156.500
EDUC	1,144	14.940	11.330	14.260	4.802	4.469	44.800
INVEST	2,060	23.670	18.930	22.350	9.138	1.525	147.900
INFL	2,272	6.455	1.865	4.235	9.996	-29.550	196.600
POPG	2,404	1.486	0.465	1.328	1.628	-4.400	17.620
TRADE	2,154	91.200	59.760	82.150	49.350	0.309	439.700
LABOUR	2,198	1.7e+07	1.1e+06	3.4e+06	7.2e+07	37,776	8e+08
AVERAGE_EDUC	1,529	7.750	5.300	8.200	3.061	1.300	13.100

Source: Own computations. 'N' stands for number of variables, 'p25' stands for percentile 25, 'p50' stands for percentile 50, 'sd' stands for standard deviation, 'min' stands for minimum and 'max' stands for maximum.

In the graph 11 and 12 (see appendices) the larger amplitude of the unit value mean is verified comparatively with the sophistication by product (PRODY) and by country (EXPY) respectively, with a higher dispersion of the unit value data. Graph 13 (see appendices) detailed this greater data dispersion of the unit value with the estimate density of the log EXPY more concentrated between 8 and 10 and the log unit value between 7 and 13.

Returning to table 2, the indicator developed in this research for exports quality, the QUALY, has a mean of 2,030 and it ranges from a value close to 0 until a maximum of 14,909. The per capita GDP (GDPPC) varies between 136 and 86,129 with a mean of 10,811 and a high standard deviation of 16,030. The next variables in table 2 are percentages except for the last two variables.

The general government final consumption expenditure (GOV) as a percentage of the total GDP has a median of 16.4% and a minimum of 2%, and the expenditure on education as percentage of total government expenditure (EDUC) has a median of 14.3% and a minimum of 4.5%. The gross capital formation is also a percentage of the GDP (INVEST) and has a median value of 22.4% and a minimum of 1.5%.

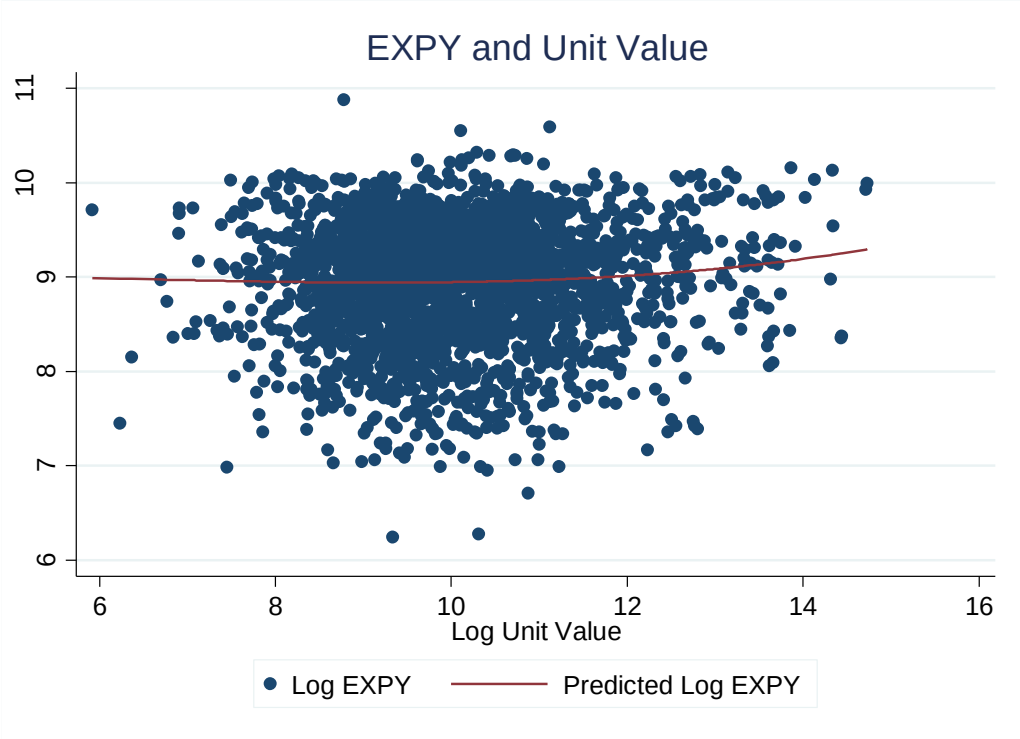
The inflation (INFL) has a mean of 6.5% and the population growth (POPG) varies between -4.4% and 17.6%. The trade (TRADE) as a percentage of the GDP has a high median of 82% and a standard deviation of 49%.

The last two variables used in this work are the labour force (LABOUR) and the mean years of schooling (AVERAGE_EDUC). The labour force is the variable with the higher values because it is a total number of active population and the values vary between a minimum of 37,776 until a maximum of 8.065e+08, the labour force of China. Finally, the mean years of schooling ranges from 1.3 to 13.1 with a mean of 7.75 years, being an important indicator of education.

The following graphs illustrate the relation between some relevant variables. Graph 4 reveals that a relationship between the EXPY and the unit value doesn’t exist but in contrast the graph 5 reveals a relation between the new quality measure (QUALY) and the EXPY, the higher the QUALY the higher the EXPY.

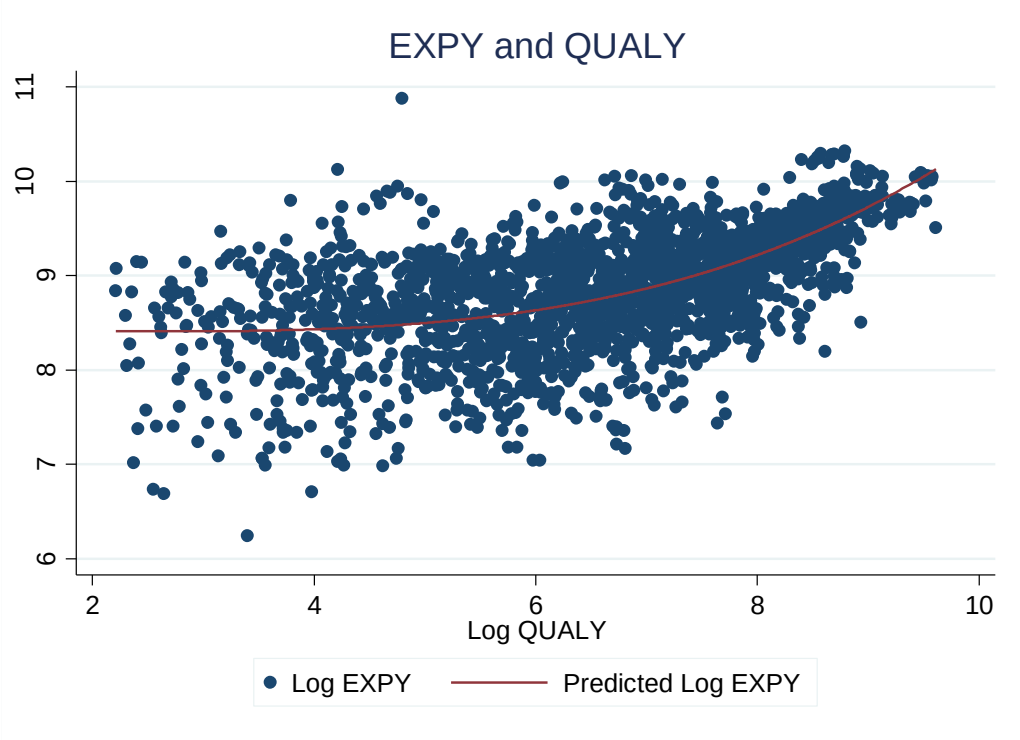
The different results exposed through the two different quality measures do not allow to attain conclusions about the exports sophistication and quality relation, however, the already mentioned unit value limitations that reflect only the exports price and not the quality, lead to the belief that the countries sophistication and quality are correlated as the QUALY variable reveals.

Graph 4 – Sophistication (EXPY) and quality (unit value)



Source: Own computations.

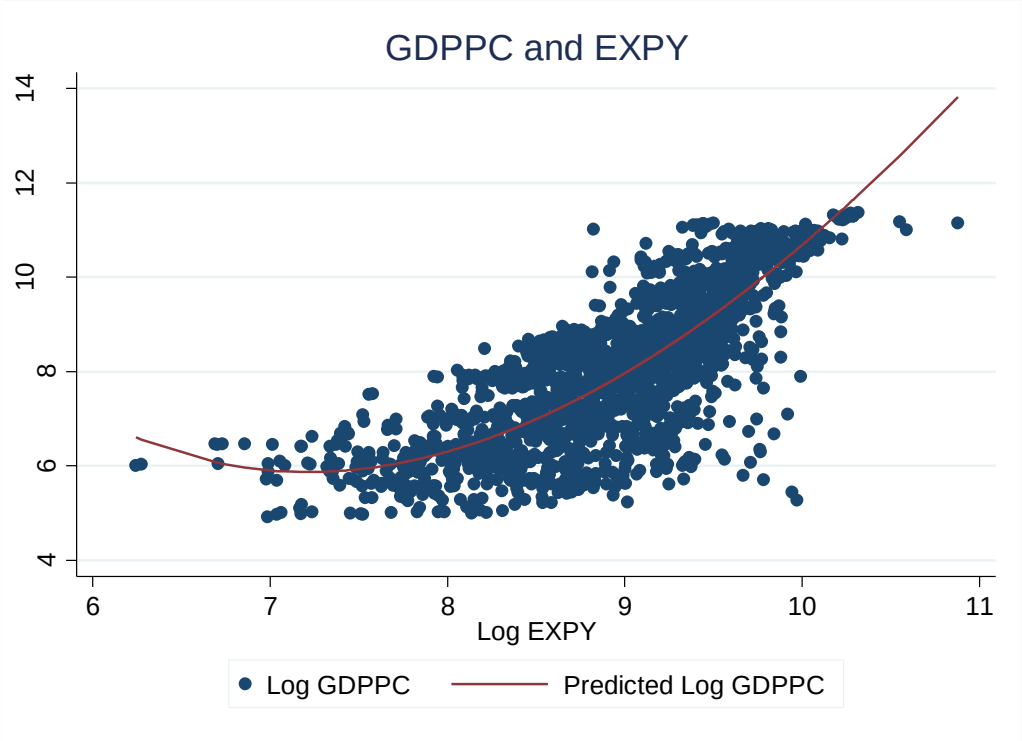
Graph 5 – Sophistication (EXPY) and quality (QUALY)



Source: Own computations.

Concerning the countries development, the following graphs present the relation of the exports sophistication and quality relating with the GDPPC. Unsurprisingly, the sophistication has a very strong relation with the GDPPC, as demonstrated in graph 6, in agreement with Hausmann, Hwang and Rodrik (2007).

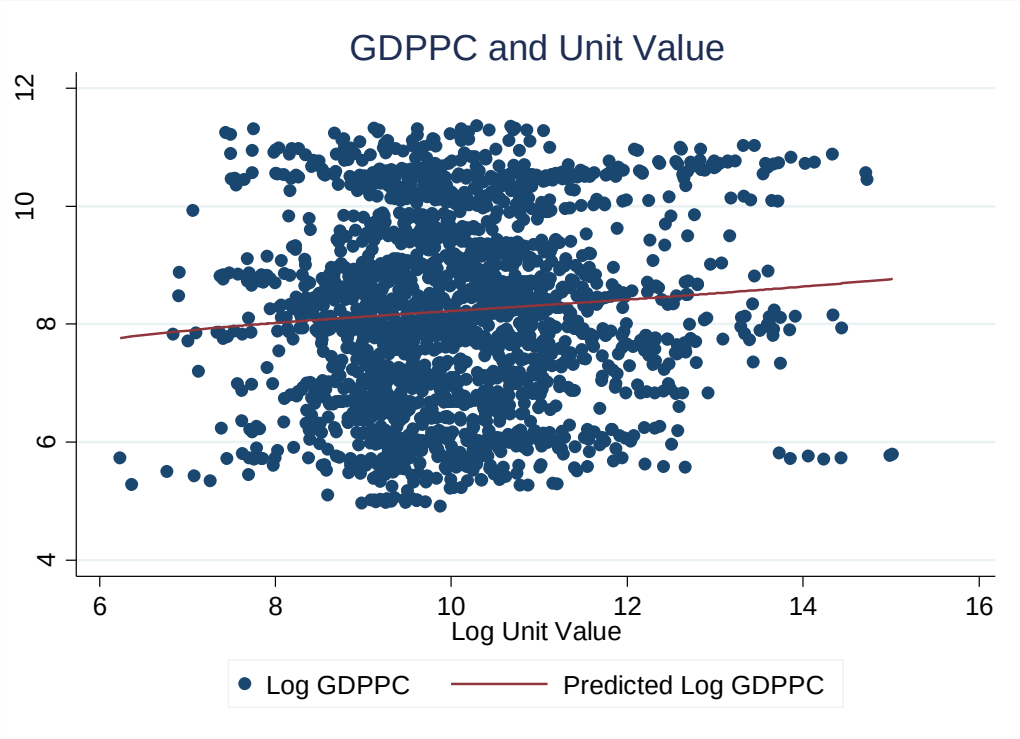
Graph 6 – GDPPC and sophistication (EXPY)



Source: Own computations.

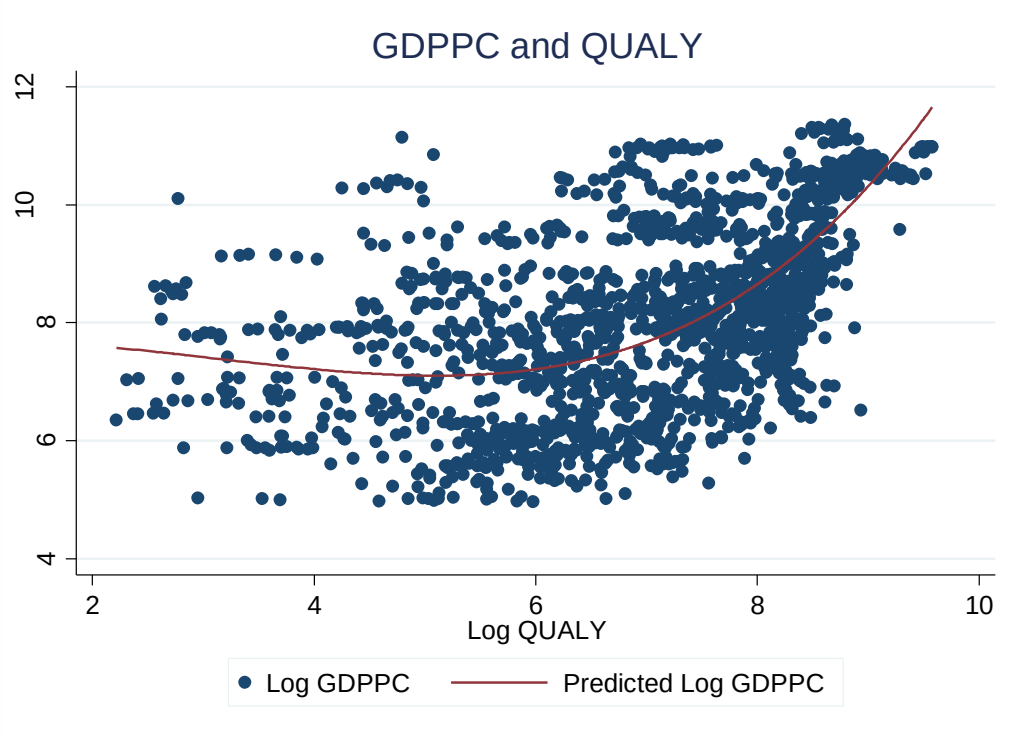
In terms of quality, different results are observed using the unit value or the QUALY indicators, graph 7 and 8, respectively. The relation with the countries GDPPC only exist using the QUALY indicator (graph 8) and thus, when measuring the quality by the unit value there is no relation. Looking to the quality through the QUALY, the relation does not exist for low QUALY values, which leads to the thinking that at an early stage the quality does not have implications to a boost in the countries GDPPC.

Graph 7 – GDPPC and quality (unit value)



Source: Own computations.

Graph 8 – GDPPC and quality (QUALY)



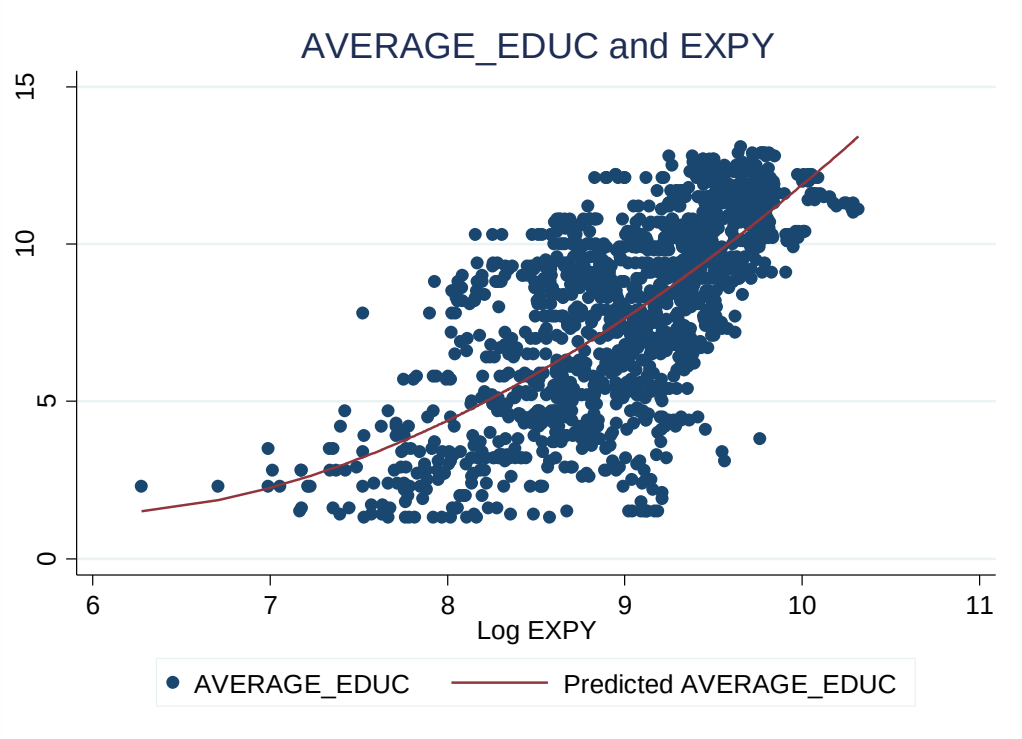
Source: Own computations.

The next graphs relate the sophistication and the quality (using the QUALY) with the countries education through the mean years of schooling (AVERAGE_EDUC). With no surprise, the education is related with both measures, being relevant for the countries to improve their education indices concerning the exports quality and sophistication.

The relation with education seems to be stronger for the sophistication (graph 9). Graph 10 reveals no relation with education for low QUALY values, suggesting that at an early stage the quality could be easier to reach by countries with lower education levels.

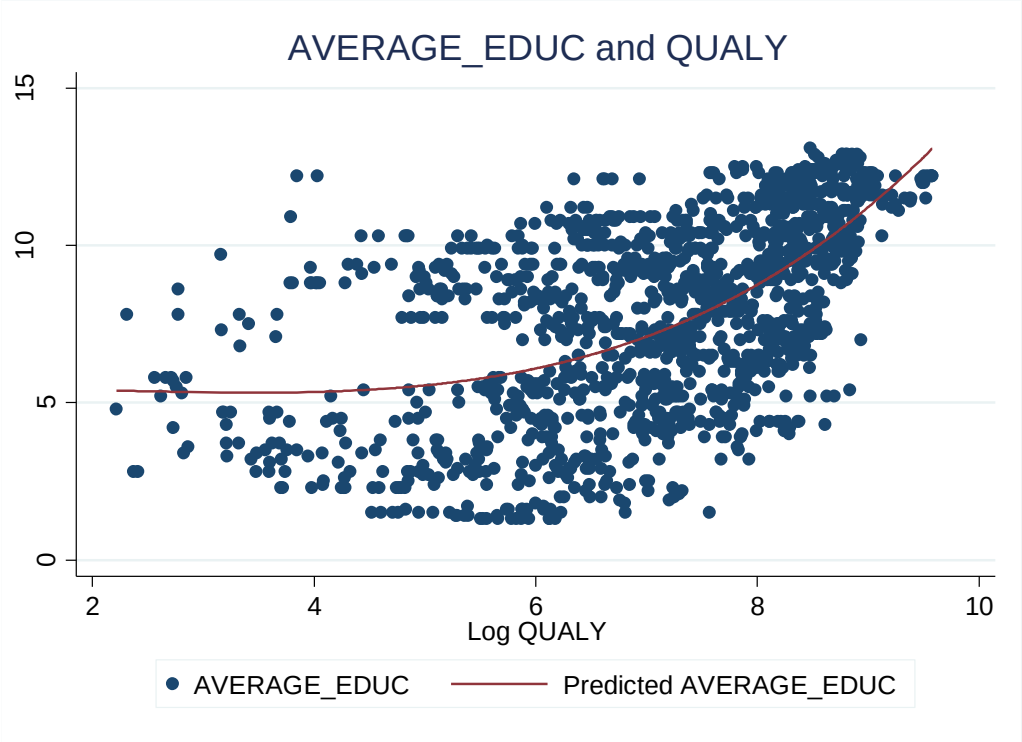
There is an association between the countries development and the exports sophistication. In turn there is no association with development and exports quality measure through the unit value in part due to the limitations of this variable. Using QUALY, there is an association with countries development and with the exports sophistication.

Graph 9 – Education and sophistication (EXPY)



Source: Own computations.

Graph 10 – Education and quality (QUALY)



Source: Own computations.

In the following table 3 the results for the baseline model are revealed, previously developed as equation 1, predicting the economic development through the dependent variable GDPPC. The first column presents a simple OLS estimation only with the sophistication (EXPY) and the quality (unit value and QUALY) as explanatory variables, the remaining variables of the equation are included in column 2. The third column fixes heteroscedasticity problems with robust standard errors and column 4 presents the random-effects estimator. In the last two columns are the results using the fixed-effects estimator, being the last column 6 used the option cluster to correct intragroup correlation and heteroscedasticity problems.

Missing values for several variables substantially reduce the initial number of countries in the estimations, from the initial 217 to 122 countries in the estimations of equation 1 and 121 countries in the estimations of equation 2, which still cover all the regions of the world.

Table 3 – Regressions of sophistication and quality and GDPPC

VARIABLES	(1) Log GDPPC	(2) Log GDPPC	(3) Log GDPPC	(4) Log GDPPC	(5) Log GDPPC	(6) Log GDPPC
Log EXPY	2.000***	1.232***	1.232***	0.137***	0.064***	0.064***
	(0.046)	(0.088)	(0.106)	(0.023)	(0.019)	(0.020)
Log unit value	0.021	-0.042*	-0.042*	0.007	0.010**	0.010**
	(0.018)	(0.023)	(0.022)	(0.005)	(0.004)	(0.005)
Log QUALY	0.041**	0.410***	0.410***	0.034***	0.022***	0.022***
	(0.018)	(0.037)	(0.053)	(0.007)	(0.006)	(0.008)
General government final consumption expenditure (% of GDP)		0.001	0.001	-0.003	-0.005***	-0.005**
		(0.004)	(0.007)	(0.002)	(0.002)	(0.002)
Log expenditure on education as % of total government expenditure (%)		-0.265**	-0.265**	-0.021	-0.014	-0.014
		(0.108)	(0.122)	(0.030)	(0.024)	(0.053)
Log gross capital formation (% of GDP)		-0.040	-0.040	0.089***	0.070***	0.070
		(0.101)	(0.117)	(0.021)	(0.017)	(0.046)
Inflation, GDP deflator (annual %)		-0.021***	-0.021***	-0.0002	0.0003	0.0003
		(0.004)	(0.005)	(0.0005)	(0.0004)	(0.0005)
Population growth (annual %)		0.094***	0.094***	0.017**	0.020***	0.020*
		(0.024)	(0.020)	(0.008)	(0.006)	(0.011)
Trade (% of GDP)		-0.002***	-0.002**	-0.0003	-0.0002	-0.0002
		(0.001)	(0.001)	(0.0003)	(0.0002)	(0.0004)
Log labour force		-0.222***	-0.222***	0.013	0.423***	0.423***
		(0.024)	(0.025)	(0.039)	(0.057)	(0.109)
Mean years of schooling (of adults) (years)		0.156***	0.156***	0.188***	0.096***	0.096***
		(0.016)	(0.018)	(0.012)	(0.012)	(0.023)
Observations	1,679	607	607	607	607	607
R-squared	0.653	0.832	0.832		0.448	0.448
RMSE	0.937	0.69	0.69			

Notes: Standard errors in parentheses. Significance level at which the null hypothesis is rejected: *** p<0.01, ** p<0.05, * p<0.1. Log is the logarithm of the variable.
Source: Own computations.

Some results do not conform to the expectations, in part due to the fact of the time series being short relative to other studies. Another reason for some unexpected results is the fact that the model is not the most complete and the lack of some relevant variables can distort some results. Nevertheless, the model is considered efficient and most of the results are what was expected, the explanations for all the results being presented below. The results until 2009, before the world crisis, were observed and no significant differences were found, meaning that the world crisis did not affect the sample.

The EXPY is highly statistically significant and has the expected positive sign in all the estimations. The estimated coefficient starts very high and decreases gradually for more expected values in the last columns 5 and 6 of the fixed effects estimation, implying that when there is an additional one percent log EXPY change, the log GDPPC increases 6.4 percentage points.

The same happens with the QUALY results being highly statistically significant with a positive coefficient although not as strong as the EXPY. The unit value is just positive and significant in the last two columns with fixed effects estimation. These results suggest a greater relevance of the sophistication but also point to the limitations of the quality measure through the unit value.

The government expenditure (GOV) is expected to crowd out resources from the private sector as Aisen and Veiga (2013) said. Thus, the sign is negative as expected but it is only statistically significant in the last two columns with fixed effects. The same explanation is valid for the government expenditure on the education (EDUC) with a negative coefficient, which is statistically significant only in columns 2 and 3, indicating that these expenditures in education can only have effects in long terms.

In fact, education has positive effects on the GDPPC as the variable mean years of schooling (AVERAGE_EDUC) reveals with a positive and high coefficient as well as statistically significant. The same is expected for the investment (INVEST) being positive and statistically significant in columns 4 and 5.

For inflation (INFL), a negative coefficient is expected and it is confirmed, except for the last two columns with fixed effects estimation, being statistically significant in columns 2 and 3. On the other hand, the labour force (LABOUR) is expected to be positive but starts to become negative in columns 2 and 3, being positive and statistically significant in the last two columns.

The most unexpected results are population growth (POPG) and trade (TRADE) being positive at first and statistically significant in all the estimations and in the second it is negative. These results can be explained due to the fact of the explained variable being simply GDPPC and not the growth as in the Aisen and Veiga (2013) study. Table 4, presented below, reports the results for the estimations of the main equation 2 with the same explanatory variables for the explained variable the GDPPC growth. The results for the population growth and trade

become the expected, being negative and positive, respectively, both being statistically significant.

Table 4 – Regressions of sophistication and quality and GDPPC growth

VARIABLES	(1) Log GDPPC growth	(2) Log GDPPC growth	(3) Log GDPPC growth	(4) Log GDPPC growth	(5) Log GDPPC growth	(6) Log GDPPC growth
Log EXPY	-0.004	0.001	0.001	0.005	0.022**	0.022*
	(0.003)	(0.005)	(0.005)	(0.006)	(0.011)	(0.012)
Log unit value	-0.001	-0.0004	-0.0004	-0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Log QUALY	-0.0002	-0.008***	-0.008***	-0.007***	-0.003	-0.003
	(0.001)	(0.002)	(0.003)	(0.002)	(0.004)	(0.004)
General government final consumption expenditure (% of GDP)		-0.0003	-0.0003	-0.0004*	-0.005***	-0.005***
		(0.0002)	(0.0003)	(0.0003)	(0.001)	(0.002)
Log expenditure on education as a percentage of total government expenditure (%)		-0.003	-0.003	-0.006	0.002	0.002
		(0.006)	(0.006)	(0.007)	(0.014)	(0.018)
Log gross capital formation (% of GDP)		0.037***	0.037***	0.045***	0.070***	0.070***
		(0.006)	(0.006)	(0.007)	(0.010)	(0.017)
Inflation, GDP deflator (annual %)		0.001***	0.001**	0.0005**	-0.0002	-0.0002
		(0.0002)	(0.0003)	(0.0002)	(0.0002)	(0.0003)
Population growth (annual %)		-0.005***	-0.005***	-0.006***	-0.021***	-0.021***
		(0.001)	(0.001)	(0.002)	(0.004)	(0.005)
Trade (% of GDP)		0.0001*	0.0001	0.0001*	0.0004***	0.0004**
		(0.00003)	(0.00004)	(0.0001)	(0.0001)	(0.0002)
Log labour force		0.004***	0.004***	0.004**	-0.072**	-0.072*
		(0.001)	(0.001)	(0.002)	(0.034)	(0.043)
Mean years of schooling (of adults) (years)		1.10e-06	1.10e-06	-0.001	-0.015**	-0.015
		(0.001)	(0.001)	(0.001)	(0.007)	(0.012)
Observations	1,559	606	606	606	606	606
R-squared	0.004	0.154	0.154		0.222	0.222
RMSE	0.056	0.038	0.038			

Notes: Standard errors in parentheses. Significance level at which the null hypothesis is rejected: *** p<0.01, ** p<0.05, * p<0.1. Log is the logarithm of the variable.
Source: Own computations.

The main differences for the growth equation presented in table 4, besides the two already mentioned (population growth and trade), are the results for the sophistication and quality indicators.

The EXPY continues positive, except in the first column, but it is only statistically significant in the last two columns with fixed effects estimation. The unit value has a positive sign only for the last two columns and is not statistically significant and the QUALY now has a negative coefficient with statistical significance in columns 2, 3 and 4. These results reveal a lower relevance of these indicators for the GDPPC growth.

The other variables do not present relevant differences except the inflation (INFL) that is unexpectedly positive in columns 2, 3 and 4 and the mean years of schooling (AVERAGE_EDUC) that is just positive in the columns 2 and 3 losing statistical significance. These results point to some failures in the econometric model that is not complete.

A substantial difference of the tables 3 and 4 is the r-squared that is much higher in the first table, revealing that the model better predicts the simple GDPPC, with a low r-squared for the growth revealing that this model is less complete.

The results present a greater significance of the exports sophistication for both GDPPC and GDPPC growth. The exports sophistication and quality have a strong correlation with the GDPPC losing significance when predicting growth.

5. Conclusions and final remarks

By calculating the individual PRODY, for the product categories at the six-digit level of the Harmonized System (HS-6), the individual products sophistication was determined. No correlation was found between the products manufacturing level and their income level, which contradicts some previous studies as Hausmann, Hwang and Rodrik (2007). The results reveal that products with a lower manufacturing level often have a higher income level associated with it.

At the sophistication level, through the products PRODY the countries EXPY was determined, and a strong relation with the countries development was found, converging to Hausmann, Hwang and Rodrik (2007) and Jarreau and Poncet (2012) findings, indicating that countries who specialise in more sophisticated goods subsequently grow faster. Countries producing more sophisticated products are subsequently more productive, their exports basket being the determinant of their sophistication level and are closely associated with development.

At the quality level, the products unit value and the unit value mean by country was determined. Great limitations of the unit value as exports quality measure were found and an alternative exports quality indicator names QUALY was developed by the author, based on a unit value ratio, suggesting better results than that of unit value.

No relation was found between the unit value and the EXPY neither with development indicators such as the GDPPC nor education. In turn, using QUALY, a positive association with both EXPY and development was found, making the correlation between the exports quality and the exports sophistication and their complementarity inconclusive. Nonetheless, as Henn, Papageorgiou and Spatafora (2013) mention, the concepts of quality and sophistication are quite different and its upgrade should be viewed as complementary.

Therefore, further research is suggested to improve the exports quality measurement for example using the QUALY as basis. As Vandenbussche (2014) said, the measure of quality is a difficult task given that quality is an unobserved product characteristic, however the significance of the determination of the exports quality for the international trade theory is unquestionable and thus, the exports quality indicators must be improved.

Using a regression analysis, a higher relevance of the exports sophistication was found compared to that of the exports quality, in favour of an across-products specialisation. Both variables presented positive significant signs to explain the GDPPC but failed to explain growth

in part due to some limitations of the growth econometric model. The results revealed a stronger coefficient of the exports sophistication for all the estimations, suggesting that in previous years this strategy contributed more to the countries international trade and that it should be viewed with high priority for the countries development.

Despite these findings, the quality measure has some limitations and it is more difficult for the countries and for the firms to change their production to new products with a high sophistication level rather than to improve the quality of the existing products.

In other words, the results clearly indicate greater relevance for the countries to develop a sophistication ladder strategy. Although, this strategy implies several times that there are risks associated with a structural transformation as well as with producing new products and thus, to create value without significant changes in the production process, quality improvement strategies are a valid option.

These results don't suggest a relation between the products income level and their manufacturing level, in turn, in terms of quality, Khandelwal (2010) argues that the potential for quality upgrading tends to be higher in manufactures than in agriculture and natural resources and thus, a balance between the exports basket sophistication and the quality improvement potential should be found by the countries.

As mentioned by Hidalgo et al. (2007), economies grow by upgrading the type of products they produce and export, and this balance between the exports sophistication and quality could be the key for the countries international trade development. They must not just look into the short term to produce products with a high-income level if these products will become obsolete in a short period with low upgrading potential.

Hausmann and Klinger (2006) state that rich countries produce more challenging products, the "rich-country" goods. These countries lead the exports sophistication and the exports quality, having the skills needed to improve the products quality and to make new products, enriching the balance between sophistication and quality in its production and exports.

This study revealed itself a great challenge in part due to the limitations of the unit value, as mentioned above, as well as the large size of the database and the complex correlation between quality and sophistication. A better alternative to determine the exports quality, upgrading the QUALY formulas, and correlation with other export measures such as variety and productivity is recommended for further research.

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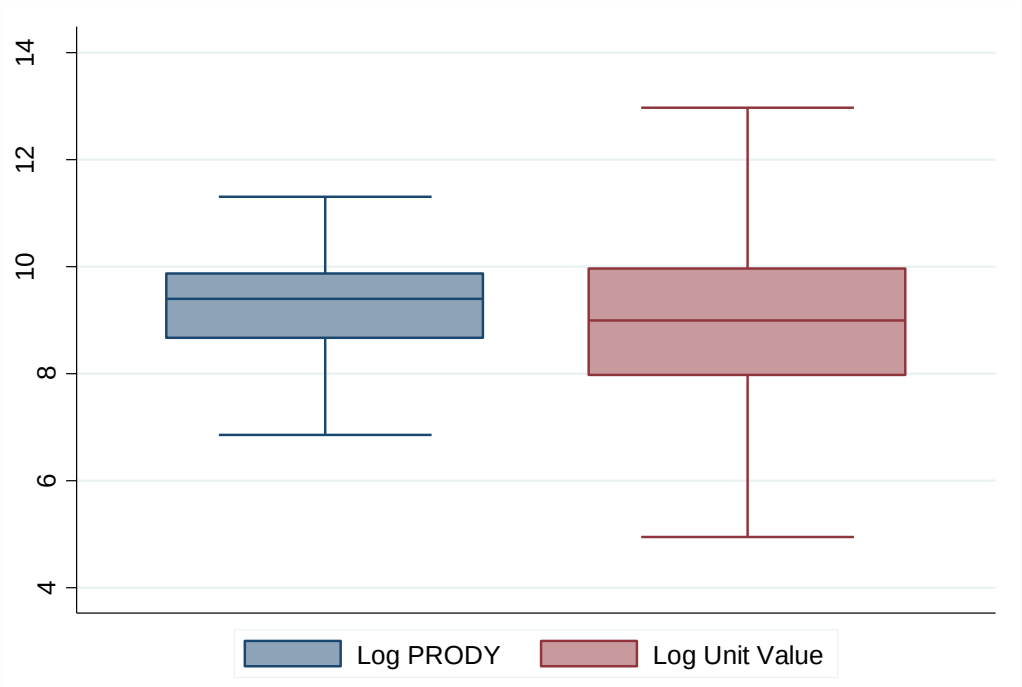
Appendices

Graph 11 – Distribution of log PRODY and log unit value

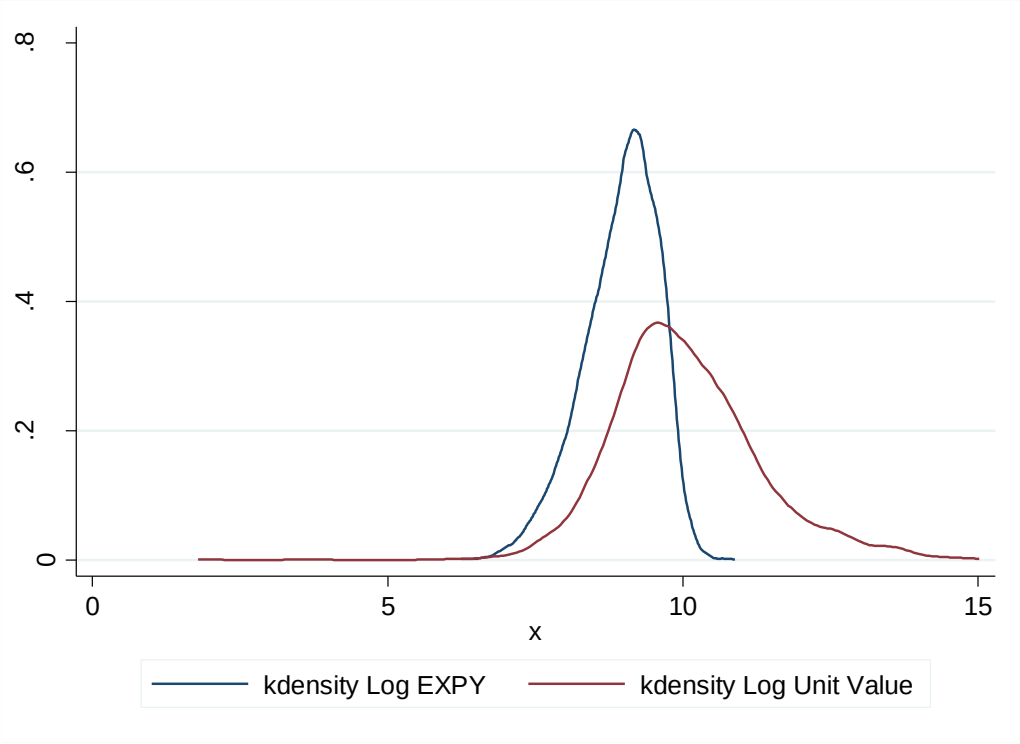


Notes: The distribution of log unit value is a mean by product.
Source: Own computations.

Graph 12 – Distribution of log EXPY and log unit value

Notes: The distribution of log unit value is a mean by country.
Source: Own computations.

Graph 13 – EXPY and unit value estimated density



Source: Own computations.

Table 5 – Largest and smallest PRODY values (products sophistication)

	Product category	Product name	Mean PRODY 2001-2014
Smallest	030421	Frozen fillets of toothfish Dissostichus spp.	284
	010613	Live camels and other camelids	403
	120740	Sesamum seeds, whether or not broken	462
	261590	Niobium, tantalum and vanadium ores and concentrates	464
	030362	Frozen toothfish Dissostichus spp.	468
	090710	Cloves, whole fruit, cloves and stems, neither crushed nor ground	471
	090510	Vanilla, neither crushed nor ground	475
	120792	Shea nuts (karite nuts), whether or not broken	498
	080131	Cashew nuts, in shell, fresh or dried	498
	410621	Hides and skins of goats or kids, in the wet state "incl. wet-blue"	581
Largest	590290	Tire cord fabric made of viscose rayon high tenacity yarns	65905
	730110	Sheet piling - iron or steel	65497
	721633	Sections, H - iron/non-alloy steel - hot rolled/drawn/extruded - height 80mm or more	58295
	030453	Other, fresh or chilled: fish of the families Bregmacerotidae, Euclichthyidae, Gadidae, Macrouridae	58082
	721069	Flat rolled products - iron/non-alloy steel (width >600mm) - plated/coated with aluminium, non-elsewhere specific	56072
	030615	Frozen Norway lobsters	55478
	030390	Frozen livers and roes	52510
	481141	Self-adhesive paper and paperboard, surface-coloured, surface-decorate	52315
	252930	Leucite; nepheline and nepheline syenite	50884
	030495	Frozen meat, whether or not minced, fish of the families Bregmacerotidae, Euclichthyidae, Gadidae, Macrouridae	49834

Source: Own computations based on current data adapted from Hausmann, Hwang and Rodrik (2007, pp. 12).

Table 6 – Ranking of countries based on average EXPY (between 2001 and 2014)

1)	Luxembourg	27301	33)	Malta	14195
2)	Ireland	23631	34)	Poland	14176
3)	Switzerland	22438	35)	Portugal	13501
4)	Finland	20475	36)	Mexico	13414
5)	Andorra	19573	37)	Estonia	13409
6)	Iceland	19366	38)	China	13364
7)	Sweden	18863	39)	Norway	13197
8)	Denmark	18409	40)	Latvia	12887
9)	Germany	18018	41)	Malaysia	12761
10)	Austria	17769	42)	Trinidad and Tobago	12706
11)	Japan	17727	43)	Greece	12570
12)	France	17107	44)	South Africa	12486
13)	Belgium	16842	45)	Australia	12439
14)	United Kingdom	16695	46)	Croatia	12379
15)	United States of America	16508	47)	Lithuania	12339
16)	Singapore	16390	48)	Belarus	11924
17)	Netherlands	16149	49)	Macao (China)	11813
18)	Italy	16141	50)	Thailand	11781
19)	Hungary	15833	51)	Barbados	11765
20)	Slovenia	15743	52)	Serbia	11737
21)	Czech Republic	15610	53)	Bahrain	11735
22)	Qatar	15589	54)	Romania	11710
23)	New Zealand	15510	55)	Faroe Islands	11258
24)	Spain	15381	56)	Russian Federation	11226
25)	Canada	15036	57)	Brazil	11105
26)	Cyprus	14891	58)	Costa Rica	10886
27)	Republic of Korea	14838	59)	Turkey	10865
28)	Bahamas	14713	60)	Ukraine	10862
29)	Greenland	14621	61)	Bulgaria	10721
30)	Slovakia	14503	62)	Oman	10672
31)	Hong Kong, China	14413	63)	Algeria	10549
32)	Israel	14384	64)	India	10281

65) Brunei Darussalam 10181
66) Saudi Arabia 10065
67) Argentina 9993
68) Equatorial Guinea 9984
69) United States Minor Outlying Islands 9818
70) Bosnia and Herzegovina 9777
71) Uruguay 9702
72) Indonesia 9673
73) Venezuela 9624
74) Azerbaijan 9514
75) Colombia 9424
76) Tajikistan 9359
77) Angola 9130
78) Kuwait 9110
79) Timor-Leste 9069
80) Aruba 9027
81) Kazakhstan 8973
82) Democratic People's Republic of Korea 8937
83) Jordan 8913
84) Gabon 8716
85) Tunisia 8716
86) Montenegro 8675
87) Iraq 8664
88) French South Antarctic Territories 8651
89) Cuba 8647
90) Gibraltar 8570
91) Philippines 8530
92) Egypt 8464
93) Swaziland 8453
94) Niue 8433
95) Viet Nam 8405
96) Tokelau 8380
97) Anguilla 8340
98) Seychelles 8329
99) British Virgin Islands 8319
100) Turkmenistan 8316
101) Ecuador 8309
102) Nigeria 8205
103) Suriname 8201
104) Republic of Moldova 8195
105) El Salvador 8144
106) St. Pierre and Miquelon 8096
107) Saint Helena 8096
108) Chad 8064
109) Panama 8050
110) Chile 8026
111) British Indian Ocean Territories 7906
112) Georgia 7826
113) Saint Lucia 7780
114) Lebanon 7771
115) Syrian Arab Republic 7728
116) Macedonia, The Former Yugoslav Republic of 7700
117) Iran (Islamic Republic of) 7671
118) Fiji 7635
119) Mauritius 7463
120) Guatemala 7329
121) Albania 7243
122) Morocco 7197
123) United Arab Emirates 7193
124) Cameroon 7163
125) Mozambique 7145

126)	Grenada	7098
127)	Dominican Republic	7070
128)	Bermuda	7054
129)	Belize	6911
130)	Yemen	6859
131)	Senegal	6852
132)	Namibia	6825
133)	Northern Mariana Islands	6818
134)	Wallis and Futuna Islands	6785
135)	Armenia	6767
136)	Sierra Leone	6744
137)	Norfolk Island	6697
138)	Saint Kitts and Nevis	6573
139)	Antigua and Barbuda	6472
140)	Bolivia	6422
141)	Botswana	6031
142)	Dominica	5991
143)	Uzbekistan	5979
144)	Samoa	5968
145)	Kenya	5887
146)	Maldives	5873
147)	Madagascar	5855
148)	Uganda	5844
149)	Paraguay	5787
150)	Honduras	5703
151)	Sudan (North + South)	5666
152)	Côte d'Ivoire	5626
153)	Pakistan	5618
154)	Liberia	5524
155)	Jamaica	5505
156)	Sri Lanka	5428
157)	Eritrea	5426
158)	Peru	5350
159)	Tuvalu	5270
160)	Libya	5259
161)	Montserrat	5088
162)	Nicaragua	5041
163)	Zambia	4987
164)	Mauritania	4914
165)	Cayman Islands	4882
166)	Congo	4854
167)	Kyrgyzstan	4730
168)	Cabo Verde	4590
169)	Bangladesh	4500
170)	Togo	4495
171)	Marshall Islands	4446
172)	Zimbabwe	4416
173)	Democratic Republic of the Congo	4409
174)	Lao People's Democratic Republic	4304
175)	Saint Vincent and the Grenadines	4263
176)	United Republic of Tanzania	4185
177)	Cook Islands	4133
178)	Bhutan	4120
179)	Haiti	4084
180)	Ghana	4012
181)	Guyana	3936
182)	Rwanda	3920
183)	French Polynesia	3757
184)	Gambia	3696
185)	Solomon Islands	3612
186)	Benin	3572
187)	Micronesia	3460

188)	Niger	3428	203)	Burkina Faso	2806
189)	Guinea	3383	204)	Djibouti	2729
190)	Nauru	3373	205)	Cambodia	2706
191)	Christmas Islands	3353	206)	Burundi	2624
192)	Sao Tome and Principe	3331	207)	Afghanistan	2518
193)	Central African Republic	3325	208)	Palau	2503
194)	Turks and Caicos Islands	3288	209)	Mongolia	2492
195)	Kiribati	3156	210)	Guinea-Bissau	2447
196)	Tonga	3066	211)	Somalia	2423
197)	Myanmar	3040	212)	New Caledonia	2400
198)	Serbia and Montenegro	3030	213)	Falkland Islands	2300
199)	Lesotho	2957	214)	Nepal	1938
200)	Malawi	2908	215)	Ethiopia	1937
201)	Mali	2838	216)	Papua New Guinea	1890
202)	Vanuatu	2818	217)	Comoros	1848

Notes: These results represent the countries sophistication. Data in US dollar thousands.
Source: Own computations.

Table 7 – Ranking of countries based on average unit value (between 2001 and 2014)

1)	Netherlands	979867	31)	Sweden	94290
2)	Switzerland	645955	32)	United Arab Emirates	91702
3)	Mauritania	524619	33)	Norway	91353
4)	Botswana	474669	34)	French Polynesia	81659
5)	United Kingdom	456145	35)	Mongolia	79571
6)	Angola	366361	36)	Zimbabwe	79302
7)	Israel	354521	37)	Singapore	76301
8)	Ireland	280860	38)	Nigeria	76085
9)	Namibia	273140	39)	Cyprus	75387
10)	Papua New Guinea	265066	40)	Saudi Arabia	73477
11)	United States of America	255596	41)	Thailand	73420
			42)	Malta	72956
12)	Sudan (North + South)	254842	43)	Uzbekistan	70745
			44)	Burkina Faso	68037
13)	Belgium	249918	45)	Denmark	66038
14)	Germany	225515	46)	British Virgin Islands	65390
15)	Hong Kong, China	218338	47)	Brazil	61241
16)	Russian Federation	213309	48)	Korea, Republic of	57092
17)	India	205600	49)	Ghana	56477
18)	Guinea	185400	50)	Colombia	56271
19)	South Africa	170576	51)	Australia	55951
20)	France	146734	52)	Finland	55794
21)	Austria	135236	53)	Equatorial Guinea	54824
22)	Canada	128393	54)	Suriname	54247
23)	Burundi	126835	55)	Myanmar	52208
24)	Japan	122579	56)	Guyana	50653
25)	China	113076	57)	Ethiopia	50324
26)	Solomon Islands	107395	58)	Niger	49410
27)	Italy	105243	59)	Spain	48680
28)	Cambodia	99975	60)	Armenia	48430
29)	Bolivia	98933	61)	Mali	46692
30)	Eritrea	98189	62)	Libya	46512

63)	Kazakhstan	45496	96)	Uruguay	29785
64)	Malaysia	44542	97)	Turkey	29326
65)	Marshall Islands	44498	98)	Cuba	29209
66)	Luxembourg	44184	99)	Mozambique	28973
67)	Iraq	43747	100)	Democratic Republic of the Congo	28896
68)	Slovakia	42778			
69)	Chile	42757	101)	Greece	28142
70)	Portugal	42623	102)	United Republic of Tanzania	27988
71)	Cayman Islands	42540			
72)	Georgia	42319	103)	Croatia	27541
73)	Czech Republic	42048	104)	Mauritius	27345
74)	Jordan	41766	105)	Djibouti	27315
75)	New Zealand	41300	106)	Peru	27165
76)	Philippines	38163	107)	Somalia	26746
77)	Poland	37714	108)	Barbados	26567
78)	Liberia	36015	109)	Pakistan	26484
79)	Mexico	35908	110)	Viet Nam	26435
80)	Iceland	35575	111)	Uganda	26047
81)	Hungary	35387	112)	Latvia	25901
82)	Ukraine	33625	113)	Belarus	25113
83)	Côte d'Ivoire	33511	114)	Honduras	24647
84)	Macao (China)	33318	115)	Greenland	24334
85)	Panama	33303	116)	Comoros	24325
86)	Morocco	32403	117)	Turkmenistan	24254
87)	Nicaragua	31908	118)	Argentina	24074
88)	Madagascar	31416	119)	Slovenia	23820
89)	Lebanon	31086	120)	Saint Helena	23766
90)	Estonia	30425	121)	Turks and Caicos Islands	23241
91)	Cook Islands	30290	122)	Lithuania	23203
92)	Zambia	30237	123)	Afghanistan	22963
93)	Kyrgyzstan	30158	124)	Swaziland	22679
94)	Indonesia	29909	125)	Ecuador	22588
95)	Fiji	29847	126)	Costa Rica	22387

127) Lao People's Democratic Republic 21964
128) Andorra 21831
129) Democratic People's Republic of Korea 21511
130) New Caledonia 21507
131) Senegal 21458
132) Aruba 21449
133) Tunisia 21278
134) Brunei Darussalam 20369
135) Sri Lanka 20180
136) Bulgaria 19820
137) Romania 19778
138) Chad 19646
139) Kenya 19506
140) Oman 19444
141) Gabon 19336
142) Nauru 19071
143) Saint Kitts and Nevis 18646
144) Congo 18408
145) Serbia 18239
146) Venezuela 17621
147) Egypt 17485
148) Bahamas 17449
149) Gibraltar 17432
150) Yemen 17100
151) Iran (Islamic Republic of) 16738
152) French South Antarctic Territories 16351
153) Seychelles 16156
154) Algeria 16066
155) Northern Mariana Islands 15769
156) Paraguay 15567
157) Cameroon 15190
158) Faroe Islands 15069
159) Dominican Republic 14816
160) British Indian Ocean Territories 14764
161) Bangladesh 14752
162) Timor-Leste 14745
163) Vanuatu 14423
164) United States Minor Outlying Islands 14294
165) St. Pierre and Miquelon 14189
166) Central African Republic 13754
167) Kuwait 13749
168) Benin 13610
169) Qatar 13602
170) Antigua and Barbuda 13351
171) Bahrain 13229
172) Niue 12982
173) Republic of Moldova 12849
174) Tokelau 12797
175) Haiti 12719
176) El Salvador 12619
177) Trinidad and Tobago 12238
178) Jamaica 11988
179) Cabo Verde 11940
180) Albania 11473
181) Guatemala 11252
182) Anguilla 11002
183) Saint Vincent and the Grenadines 10968
184) Bosnia and Herzegovina 10590
185) Montserrat 10476
186) Micronesia 10471

187)	Malawi	10418	202)	Bhutan	7965
188)	Saint Lucia	10274	203)	Tajikistan	7847
189)	Palau	10201	204)	Montenegro	7486
190)	Sierra Leone	10003	205)	Rwanda	7398
191)	The Former Yugoslav Republic of Macedonia	9906	206)	Tuvalu	6817
			207)	Kiribati	6784
192)	Falkland Islands	9806	208)	Dominica	6398
193)	Grenada	9658	209)	Samoa	6170
194)	Serbia and Montenegro	9628	210)	Togo	5978
195)	Belize	9447	211)	Tonga	5845
196)	Azerbaijan	9321	212)	Lesotho	5603
197)	Nepal	9306	213)	Maldives	4841
198)	Wallis and Futuna Islands	8967	214)	Syrian Arab Republic	4325
199)	Christmas Islands	8894	215)	Guinea-Bissau	3875
200)	Norfolk Island	8419	216)	Sao Tome and Principe	3631
201)	Bermuda	8009	217)	Gambia	3152

Notes: These results represent the countries quality. Data in US dollar/tons.
Source: Own computations.

Table 8 – Summary of the key results available in the literature

Author's	Dependent variable	Independent variable
Schott (2004)	Log unit value	Log GDP per capita (+) *** Log capital per labour (+) *** Log skill per labour (+) **
Hausmann, Hwang & Rodrik (2007)	Log EXPY	Log GDP per capita (+) *** Log human capital (+) Rule of law index (+) Log population (+) *** Log land area (-) **
	Growth rate of GDP per capita	Log initial GDP per capita (-) *** Log initial EXPY (+) *** Log human capital (+) Log capital-labour ratio (+) Rule of law index (+) **
Kumakura (2007)	Log EXPY	Log GDP per capita (+) *** Log labour force (-) Log population (-) ** Distance (-) ***
	GDP growth rate	Log EXPY (+) *** EXPY (+) Log GDP per capita (-) ** Log labour force (+) * Distance (-)
Schott (2008)	Log unit value	Log real GDP per capita (+) *** Log skill abundance (+) ***
Cabral & Veiga (2010)	Export sophistication	Population (+) *** Income per capita (+) *** Landlocked country (-) Oil net exporting countries (+) Arable land (-) *** Government accountability (+) Political stability (+) Control of corruption (-) ** Effectiveness (-) Regulatory quality (-) *** Debt policy rating (+) *** Economic management cluster average (+) ** Equity of public resource use rating (+) *** Debt policy and the fiscal policy rating (+) *** Gender equality (+) *** Policies for social inclusion (+) *** Transparency accountability and control of corruption in the public sector (+) ***

	GDP growth	Export diversification (+) ** Export sophistication (+) **
	YPC growth	Export diversification (-) * Export sophistication (+) ***
	Export growth	Export diversification (+) *** Export sophistication (+) ***
Khandelwal (2010)	Quality	Log GDP per capita (+) *** Log capital-labour ratio (+) *** Log education (+)
	Quality ladder	Log capital intensity (+) ** Log skill intensity (-) Log total factor intensity (+) Marketing intensity (+) R&D intensity (+) **
Minondo (2010)	GDP per capita growth	Log initial GDP per capita (-) * Log EXPY (+) *** Log initial human capital (+) *** Initial rule of law (+) Log initial capital-labour ratio (-)
Xu (2010)	Log EXPY	Log GDP per capita (+) ***
Mishra, Lundstrom & Anand (2011)	GDP per capita growth	Log initial GDP per capita (-) *** Log initial service EXPY (+) *** Log human capital (+) Log financial development (+) * Trade (% of GDP) (+) *** Rule of law (-)
Feenstra & Romalis (2012)	Export quality	Log GDP per capita (+) Log population (-) Manufacturing trade (+)
Jarreau & Poncet (2012)	Real GDP per capita growth	Initial real GDP per capita (-) *** Export sophistication (+) *** Investment rate (+) Human capital (+) ** Openness rate (+) FDI over GDP (+) Share of state in investment (-)
Henn, Papageorgiou & Spatafora (2013)	Growth in product quality	Log initial quality (-) *** Log initial GDP per capita (-) Initial institutional quality (+) *** Initial human capital (+) ***
Vandenbussche (2014)	Log price	Log quality (+) *** Log cost (+) ***
Gervais (2015)	Price	Log quality (+) *** Log productivity (-) *** Export status (+) ***
	Marginal cost	Log quality (+) *** Log productivity (-) *** Export status (+) ***
	Cost of production	Log quality (+) ***

		Log productivity (-) *** Export status (+) ***

Notes: (+) and (-) report the signal of the effect, while stars indicate the significance level (*** p<0.01, ** p<0.05, * p<0.1).
Source: Own development based on literature review.