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Fostering the development of the coffee global value chain

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KIEL WORKING PAPER

Fostering the Development of the Coffee Global Value Chain



No. 2170 December 2020

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and Finn Ole Semrau*

ABSTRACT

FOSTERING THE DEVELOPMENT OF THE COFFEE GLOBAL VALUE CHAIN*

Dennis Görlich, Aoife Hanley, Wan-Hsin Liu, and Finn Ole Semrau

The overarching aim of the study is to investigate the key factors that determine how and how intensively countries can be integrated into the coffee global value chain (GVC) and thus can better reap the globalization benefits. The empirical analysis shows how the international trade in coffee has developed across regions/countries over the past three decades. It provides evidence-based insights into the key determinants of countries' GVC integration in the coffee industry. It discusses countries' functional and product upgrading for their GVC integration. Based on the empirical results obtained, policy implications are derived to support the further development of the coffee GVC. This study serves as a background study for the Coffee Development Report 2020 in preparation by the International Coffee Organisation.

Keywords: coffee, trade, development, global value chain, upgrading

JEL classification: F14, O13, O30

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The responsibility for the contents of this publication rests with the author, not the Institute. Since working papers are of a preliminary nature, it may be useful to contact the author of a particular issue about results or caveats before referring to, or quoting, a paper. Any comments should be sent directly to the author.

1 Introduction

International trade is widely recognised as a key driver of economic growth, poverty reduction and societal development. The United Nations thus considers international trade as an important instrument for individual countries and the world as a whole to achieve the 2030 Sustainable Development Goals (SDGs) (see UNCTAD, 2020a; UN, 2020).

The three key SDG targets linked to trade aim at promoting a multilateral trading system under the World Trade Organisation (WTO) (Target 17.10), significantly increasing the exports of developing countries, particularly of the least developed countries (Target 17.11) and providing duty-free and quota-free market access on a lasting basis for all least developed countries (Target 17.12) (UN, 2020). The particular attention that the UN gives to developing countries in this regard makes it clear that these countries still lie strongly behind as to their integration into the international trade and thus are farther away from benefiting from trade for their development.

The still weak link of some developing countries to the international trade represents at the same time a development opportunity for the future. With the gradual liberalization trend of the international trade in which the Uruguay Round, that led to the establishment of WTO in 1995, played a critical role and the strong technological progress in transportation, information and communication, it has been much less costly for firms to procure resources and intermediate goods needed for better prices abroad, and to sell their products globally. As a result, global value chains (GVCs) have been quickly developed and extended since the 1990s. GVC growth is often seen as one of the main reasons behind the rapid growth of international trade (Yi, 2003). Although GVC growth has been slowed down since the financial crisis in 2008 due to, for example, the decline in overall economic growth, the rising protectionism and intensifying trade tension (IBRD & World Bank, 2020), the extended development of GVCs and the advanced technologies over the last decades could still provide much more possibilities than before to firms, including those from the developing countries, with weak link to the international trade, to get better integrated into the GVCs.

Against this background, the overarching aim of this study is to investigate the key factors that determine how and how intensively countries can be integrated into GVCs and thus be able to reap the globalization benefits. It focuses on the coffee industry for the analysis. The annual revenue of the coffee industry is estimated to be more than \$200 billion according to the Coffee Development Report 2019 from the International Coffee Organization (ICO, 2019). The same report also highlights that only around \$20 billion of the estimated annual revenue of the coffee industry are appropriated by the world's coffee growers.¹

Why do these nations (many of whom are designated as low- or middle-income countries according to the World Bank's country income classification (World Bank, 2019)) continue to export 70 percent of their green coffee, without undertaking any processing? Why do they appear unable to extract additional revenue from coffee processing? Will the coffee industry in these producing countries remain

¹ "Coffee growers", "coffee growing countries" and "coffee producing countries" are used in this study to refer to countries that harvest coffee. "Coffee processing countries" refers to countries that implement processing work on coffee beans that they harvest on their own or import from others. "Coffee exporting/importing countries" are countries that export/import green coffee or the more processed coffee forms such as roasted coffee or soluble coffee.

handicapped by productivity problems? Will growers continue to remain vulnerable to shocks on the commodity markets? These problems were revealed in related previous studies including the Coffee Development Report 2019 (ICO, 2019) and a recent ICO study on the impact of the Covid-19 pandemic on the coffee sector (ICO, 2020a).

Many of the problems hinge on issues with stakeholders within the production chain. For this reason, practitioners in the coffee industry have highlighted the importance of engaging with stakeholders across the entire industry (ICO, 2019). These stakeholders comprise producers, distributors and retailers in the (largely) industrialised coffee importing countries and growers in the (largely) developing– and middle-income coffee growing countries.

On the supply side, there are a few additional sobering facts to digest. Consider the portion of arable land devoted to Fairtrade production. In the period 2016 and 2017 the percentage devoted to cocoa (number one Fairtrade commodity in terms of land use) increased by 62 percent. By comparison, the area of cropland devoted to Fairtrade coffee decreased by 10 percent (Tchibo, 2020).

Despite these troubling changes in the coffee industry, there remains a core of stakeholders such as NGOs, customers and the coffee industry itself who are committed to working towards making the industry more sustainable. The adoption of Resolution 465 “Coffee Price Levels”, by the International Coffee Council, underpins this resolve (ICO, 2019). Fundamental to the initiative of dealing with the problem of falling and volatile prices, is to explore new ways for circumventing these supply and demand shocks. At the level of the grower, the time is ripe for an assessment of the factors which help (and hinder) stakeholders in coffee producing countries.

The Coffee Development Report 2019 highlights some stark facts. In sum, the industry is characterized by oversupply, depressed prices, poor incomes, inadequate investment and low productivity of growers (ICO, 2019). These worrying developments in the industry have prompted one commentator to note that “(the) coffee sector may not be able to make its critical contribution to achieving the Sustainable Development Goals (SDGs) of the United Nations.” (ICO, 2019: 10).

There is an obvious route out of this underinvestment and poverty spiral. This is where GVCs can play a role. Additional industry gains may be achieved by boosting value added, thereby raising investment and improving productivity. All these industry-specific characteristics make the coffee industry a well-suited case study for investigating the key factors that may affect how and how intensively countries can be integrated into coffee GVC and thus can reap the globalization benefits.

The empirical analysis is based on a large-scale country-level dataset with key data mainly provided by the International Coffee Organization (ICO) and collected from other international organizations such as the World Bank and the International Labour Organization. The study is organised as follows. Chapter 2 focuses on examining the general development of the international trade in coffee over time. It starts with introducing the data and methodologies used for the analysis, followed by presenting the empirical evidence as to the development of coffee trade over time and across regions/countries. The analysis mainly focuses on the development of coffee exports to gain more insights into how regions and countries have been integrated in the coffee GVC. Chapter 3 focuses on investigating the determinants of countries’ GVC integration in the coffee industry. It starts with providing economic reasoning for the relevance of GVC integration for development, followed by proposing three types of indicators that can be used to measure countries’ GVC integration for the coffee industry. It then introduces the econometric model and data used for the analysis and presents the key findings. Chapter 4 presents

and discusses related policy implications derived from the empirical findings in the last two chapters. Chapter 5 concludes.

2 Development of international trade in coffee

Chapter 2 examines the general development of international coffee trade over time. It begins with describing the overall coffee trade development over time, followed by identifying more disaggregated development patterns in coffee trade considering different coffee forms and regions/countries involved. It mainly focuses on the development of coffee exports to gain more insights into how regions and countries have been integrated in the coffee GVCs.

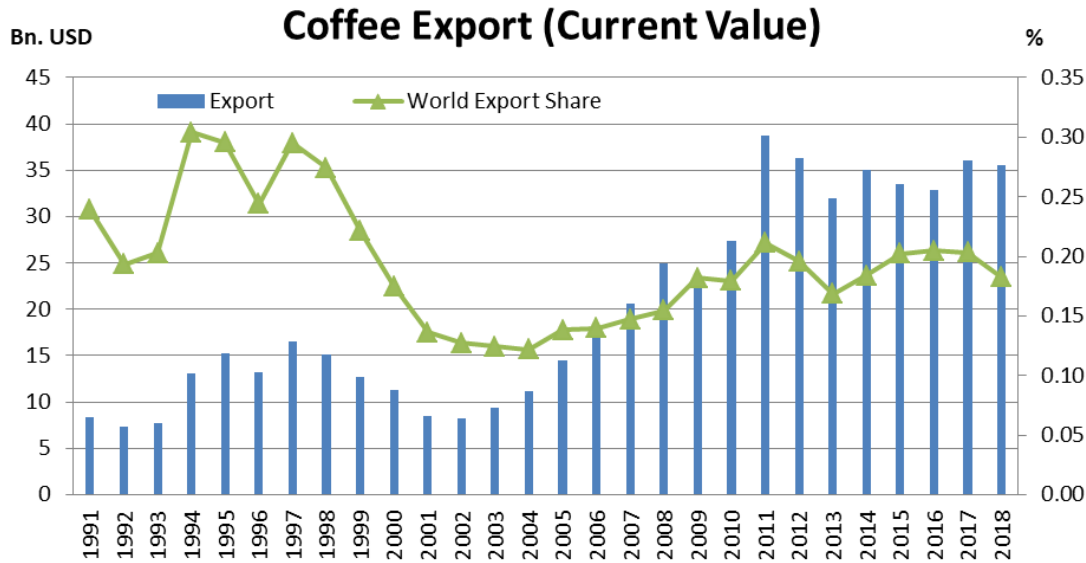
2.1 Overall development of coffee trade

Based on the bilateral cross-border coffee transaction data from ICO (ICO, 2020b), a coffee trade panel dataset covering 240 countries/economies and 28 years (1991–2018) is prepared and used as the core dataset for the analysis.² The dataset includes export and import statistics both in value and in volume. The statistics are available for three coffee forms: green coffee, roasted coffee and soluble coffee.

The annual cross-border coffee exports of the 240 countries considered more than quadrupled over the past almost three decades, moving from \$8.4 billion in 1991 to \$35.6 billion in 2018 (Figure 1). This was, however, rather a result of a strong increase in coffee trade from 2004 to 2011. Before 2004 the increase in coffee trade was rather moderate. In relative terms, it grew even at a much lower rate than the world trade in general, leading to a strong falling trend in the share of coffee trade from 0.30% of world trade in 1994 to 0.12% in 2004. With increasing coffee trade since then, its share in the world trade rebounded to about 0.21% in 2011. In the recent past, the coffee trade value did not further increase but stayed at a relatively high level between \$31 and \$36 billion. Since the growth in world trade has slowed down over the past years, the share of the coffee trade in world trade rather stagnated at around or fell only slightly below 0.20%.

² A full list of countries/economies considered in the dataset is provided in Table A1 in the appendix.

Figure 1: Development of the coffee export over time

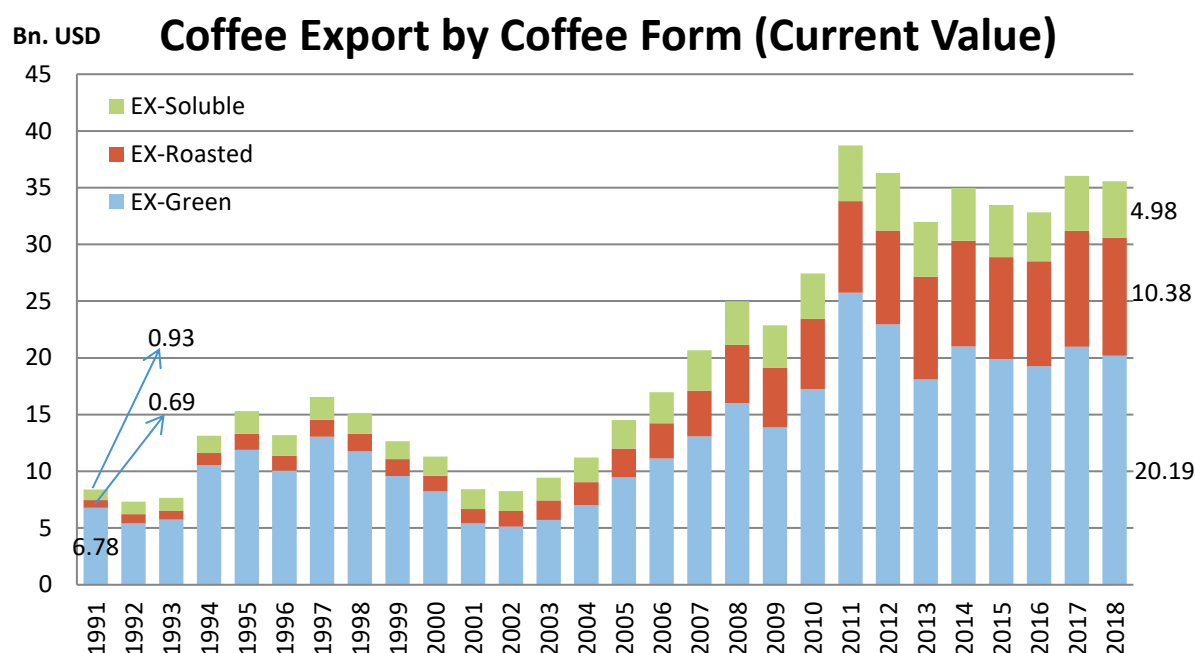


Source: ICO (2020b) and UNCTAD (2020b).

2.2 Overall development of coffee trade

The coffee products in international trade can be differentiated in three forms: green coffee, roasted coffee and soluble coffee. Compared to the green coffee, more processing work is required for the production of the roasted coffee and soluble coffee. As shown in Figure 2, no homogenous developing trend can be observed for the export of these three coffee forms. Instead, the roasted coffee exports grew much more substantially over time, followed by the soluble coffee exports. They both accounted for (much) higher shares of the coffee exports in 2018 (29% for roasted coffee; 14% for soluble coffee) than in 1991 (8% for roasted coffee; 11% for soluble coffee).

Figure 2: Distribution of the coffee trade by coffee form and its development over time



Source: ICO (2020b).

In addition to the export value in current prices, the export statistics for the three coffee forms are also available in constant value (inflation adjusted value with 2015 as the base year) and in volume (tsd. 60kg bags). The finding above that the export of coffee forms that require more processing work (roasted coffee and soluble coffee) increased much more strongly than the green coffee exports stays qualitatively unaffected after removing the effects of price changes from the export statistics by considering the coffee exports at constant prices or in volume.

Focusing on the coffee exports at constant prices and in volume, i.e., focusing on the inflation adjusted development in coffee trade, Table 1 shows the growth rate of coffee exports between the most recent four years and the first four years of the research period for all three coffee forms.

In line with the findings above, the growth rates of the roasted coffee exports – both at the constant prices and in volume – were the highest among the three coffee forms, followed by the growth rates of the soluble coffee exports, while the growth rates of the green coffee exports were the lowest.

Table 1: Growth rates of coffee exports (at constant prices and in volume) between the period 1991–1994 and the period 2015–2018 by coffee form (%)

| | Constant Value (price of 2015) | Volume |
|-----------------------|-----------------------------------|--------|
| Green Coffee Export | 65.98 | 57.19 |
| Roasted Coffee Export | 577.43 | 397.06 |
| Soluble Coffee Export | 132.56 | 221.83 |

Notes: The growth rate is calculated as follows: $\left(\frac{\sum_{t=2015}^{2018} X_t - \sum_{t=1991}^{1994} X_t}{\sum_{t=1991}^{1994} X_t}\right) * 100\%$, where X refers to the respective export activity considered.

Source: ICO (2020b).

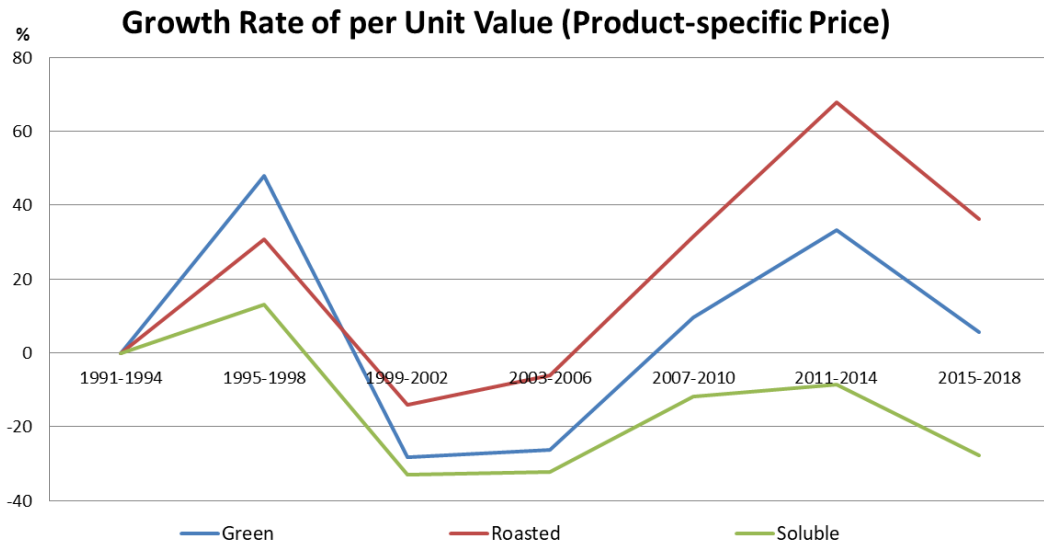
As shown in Table 1, the growth rate of the roasted coffee exports in constant value was much larger than that in volume. For the green coffee exports, the growth difference was much smaller but still positive. For the soluble coffee exports, the former was even smaller than the latter. Since the difference between the growth rate of exports in constant value and that of exports in volume is driven by the growth rate of per unit (export) value of the coffee form considered, the findings suggest that the prices of both the exported roasted coffee and the exported green coffee increased over time, while the price increase for roasted coffee was much larger than that for green coffee. In contrast, the price of the exported soluble coffee rather decreased over time.

Figure 3 shows the price development for the three coffee forms over the whole research period. The basic developing trends for the three coffee forms were actually similar to each other, suggesting that the price development of green coffee also played a role in determining the price development of the more processed coffee forms. This is plausible, since the per unit export value here is a gross but not a net value. Price changes in green coffee can affect the production costs of the more processed coffee forms such as roasted coffee and soluble coffee.

Despite the similar basic developing trends, the price increases (decreases) in exported roasted coffee over the research period were larger (smaller) than those in exported green coffee since the late 1990s. Such difference suggests that roasted coffee providers succeeded in additional price and/or quality-improving innovation that further drove upwards the per unit value of the exported roasted coffee or at least helped mitigate the market pressure upon their prices.

Following this line of thought, the finding that the price of exported soluble coffee decreased more strongly (increased less strongly) than that of green coffee in most periods considered, is actually surprising. Such development can be a sign of countries' failure in product innovation to improve soluble coffee quality but can also be a result of a strongly expanding supply of soluble coffee in the global market that can be, for example, driven by an increasing number of soluble coffee providers worldwide and/or supported by more advanced technologies used in the production that enhanced production efficiency.

Figure 3: Growth rate of per unit value by coffee form over time

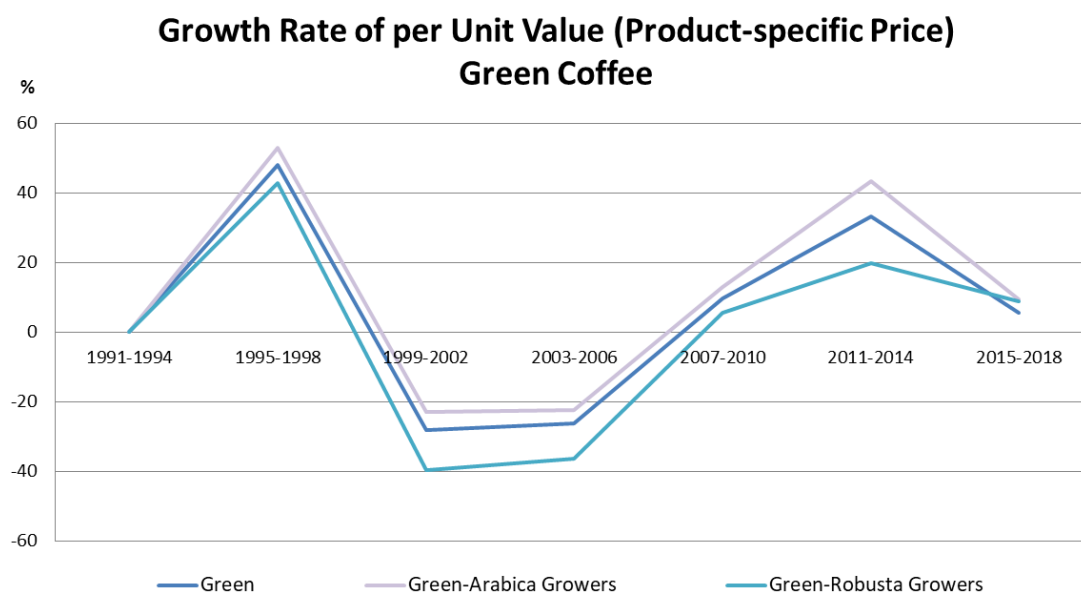


Notes: The growth rate of price is calculated in the same way as in Table 1, i.e., the per unit export value in the first period (1991–1994) are used as base prices. The per unit export value is calculated by dividing the inflation-adjusted export value by export volume.

Source: ICO (2020b).

To better take into account the fact that green coffee is no homogeneous good and the Arabica coffee is of higher quality than the Robusta coffee, the growth rate of the per unit value of the green coffee exports is also calculated by differentiating whether the exporting countries which also grow green coffee harvest mainly Arabica coffee beans or Robusta coffee beans (Figure 4). For comparison, the development of the growth rate of price for the green coffee exports shown in Figure 3 is presented in Figure 4 as well. As shown in Figure 4, the growth rate of price for green coffee exported by Arabica growers had a developing trend that was highly similar to that of the green coffee exports in general, while this was less the case for green coffee exported by Robusta growers. In line with the expectation, the price growth rate of the exported green coffee achieved by Arabica growers was in most periods much larger than that achieved by Robusta growers.

Figure 4: Growth rate of per unit value (product-specific price) for green coffee



Notes: The growth rate of price is calculated in the same way as in Figure 3. Countries are classified as Arabica (Robusta) growers if they, according to coffee production statistics, harvest coffee beans and if their harvest is mainly Arabica (Robusta) coffee.

Source: ICO (2020b).

The findings in this section suggest that both the strong increase in price and the strong expansion of exported volumes played an important role for the substantial increase in the roasted coffee exports. While the price increase and the volume expansion also contributed to the export increase of green coffee, the price contribution here was stronger in case of Arabica growers as exporters than in case of Robusta growers. The price contribution in green coffee exports was, however, smaller than that in case of the roasted coffee exports in most periods. In case of the soluble coffee exports, the contribution of the volume expansion clearly dominated with the soluble coffee price in comparison to the base period of 1991–1994 having decreased in most year periods considered.

In a nutshell, the analysis above suggests that there are two ongoing upgrading trends in the coffee GVC. First, there is functional upgrading. The coffee production and trade worldwide turned to focus more on coffee products requiring more processing work, namely roasted coffee and soluble coffee. Second, there is product upgrading. The increasing prices of the exported roasted coffee and green coffee (particularly from Arabica growers) signalled some improvement in product quality over time, with the price increase (quality improvement) being more substantial for the former than the latter.

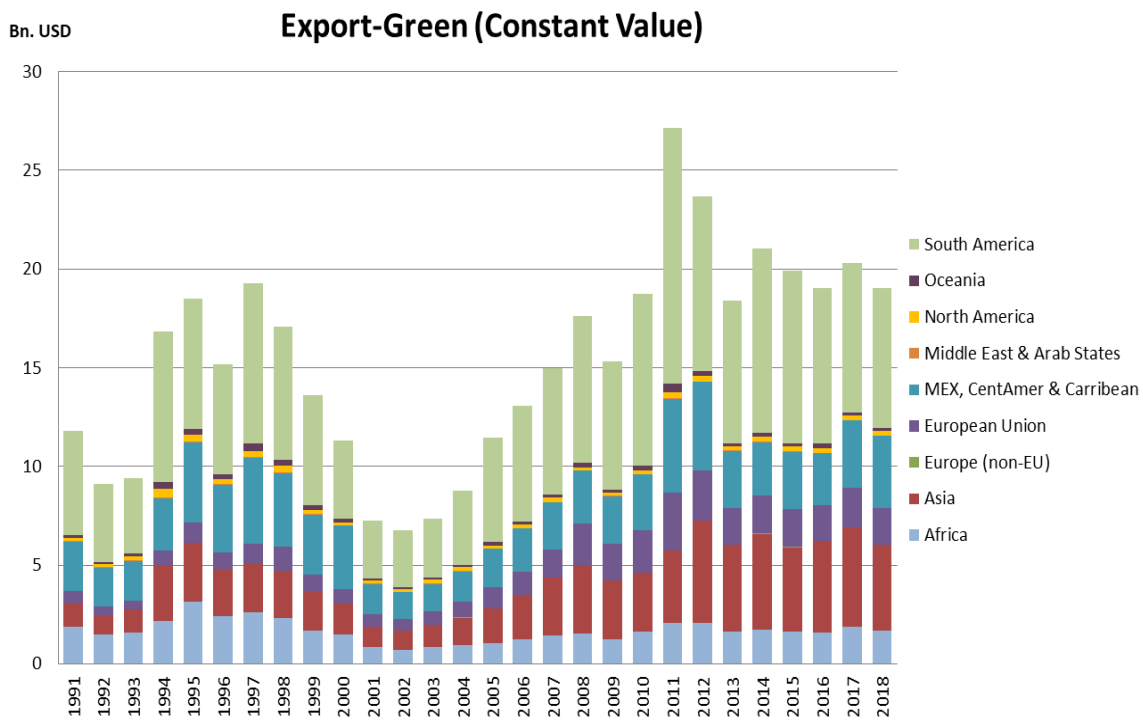
2.3 Coffee trade by region

The increasing weight of the soluble coffee and especially the roasted coffee in coffee trade suggests a forward development along the coffee GVC, with more processing work being required in the coffee production today that also leads to higher added value. This raises a question of which region has benefitted most from this developing trend in the coffee GVC, i.e., which region accounted for a larger export share of the more processed coffee forms and thus achieved a higher share of value added over time.

The development of the regional distribution of coffee export by coffee form over time is presented in Figure 5, by using the related export statistics in constant value provided by ICO (ICO, 2020b).³ Using these statistics enables us to consider both the quantity impact and the product-specific price development and leave the inflation influence out of the analysis.⁴

Figure 5: Regional distribution of the coffee trade by coffee form and over time

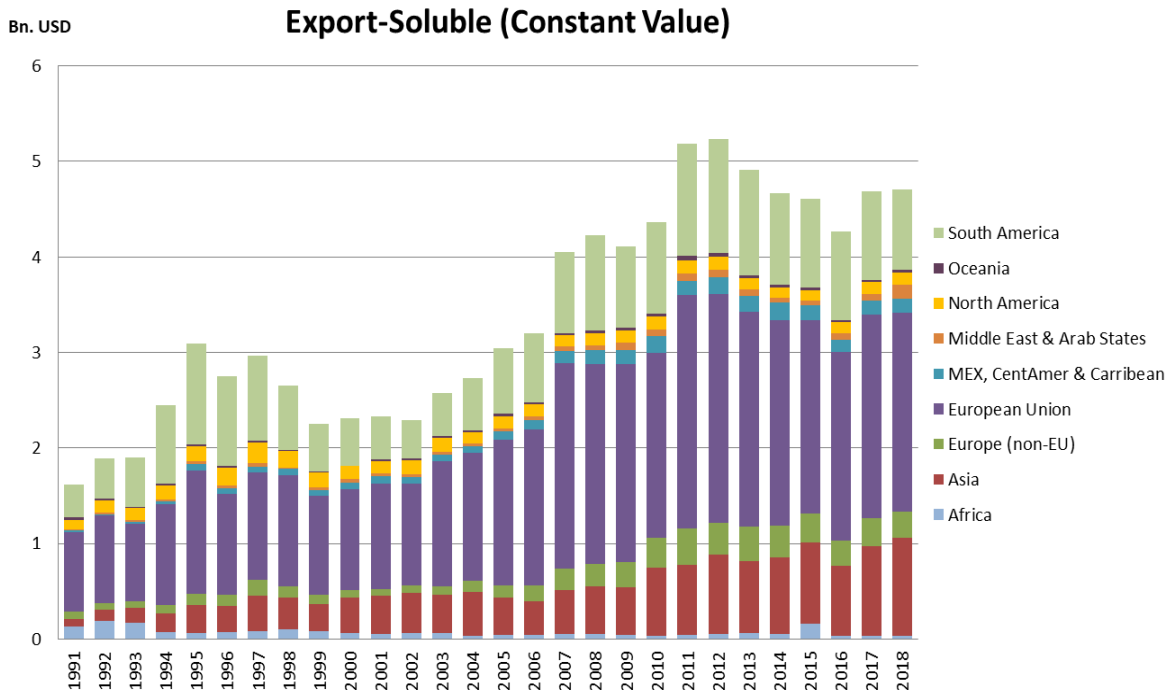
(a) Green coffee



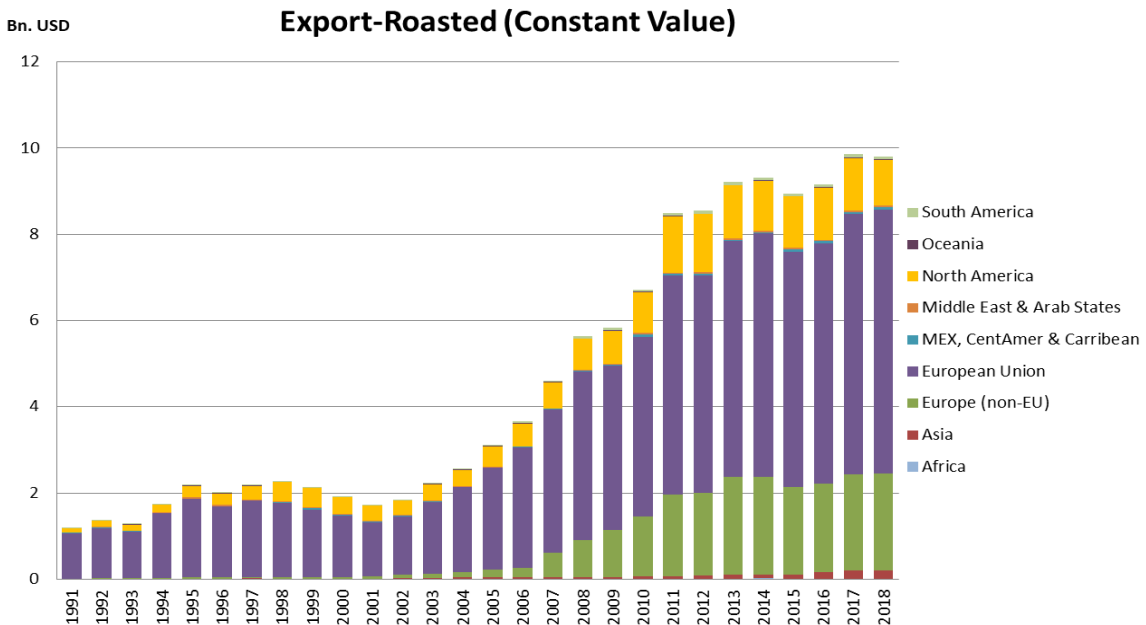
³ In total nine regions are considered for the analysis based on the regional classification used in the ICO statistics. More information about countries' regional classification can be found in Table A1 in the appendix.

⁴ Statistics in constant value are used for the remaining analysis in this section, as far as nothing else is mentioned.

(b) Soluble coffee



(c) Roasted coffee



Source: ICO (2020b).

As shown in Figure 5, countries in economically more advanced regions such as the European Union, Europe (non-EU) and North America were highly dominant in exporting roasted coffee that generally requires more production processing work and has a higher product value. In 2018 these three regions accounted for more than 96% of the roasted coffee exports. They also dominated the soluble coffee exports, but with a much smaller share of about 53% in the same year. Additionally, a comparable

regional distributional analysis based on the green coffee import statistics show that they imported the majority of green coffee that was traded worldwide (76% in 2018).⁵

In strong contrast, these economically more advanced regions were responsible for only about 11% of the green coffee exports. Instead, countries from South America, Asia, Central America and Africa, where a great amount of countries are developing or emerging countries, played a more dominant role in the green coffee exports (88% in 2018). Since these regions were also the main coffee growers (99% of the world coffee production in 2018), their strong dominant role in the green coffee exports is not surprising.

All these findings suggest that the economically more advanced regions tend to be more strongly involved in the processing work of the coffee and they rely strongly on green coffee imports from the less developed regions but not own green coffee production for their coffee processing work.⁶

This, however, does not mean that there was no development in the group of the coffee exporters and economically less developed countries were completely excluded from being involved in the processing tasks of the coffee GVC. Against the background that the European Union, Europe (non-EU) and North America continuously accounted for more than 95% of roasted coffee exports over the whole research period, it can be observed, for example, that the countries in Europe (non-EU) played an increasingly important role as roasted coffee exporters (from 0.4% in 1991 to 23% in 2018). Over the same period, the share of the European Union in the roasted coffee exports substantially shrank from 88% in 1991 to 63% in 2018. In case of the soluble coffee exports, substantial regional dynamics can also be observed. Here countries in Middle East and Arab States and in particularly Asia increased their shares in the soluble coffee exports. Countries in Asia, for example, quadrupled their market share from 5% in 1991 to 22% in 2018. Their market expansion occurred at the costs of the market share of the European Union and North America that fell from 58% in 1991 to 47% in 2018.

Such development suggests that although the traditionally economically more advanced regions seemed to be more integrated into the processing part of the coffee GVCs, a few other countries moved up the coffee GVCs and became more involved in such processing work over time. Still, countries particularly in Africa and South America seemed to be less successful in such functional upgrading in the coffee GVC. Their shares in exports of the more processed coffee forms decreased or stagnated at an extremely low level over the research period.

2.4 Country involvement in coffee trade

2.4.1 Involvement in trade via functional upgrading

Do the developing trends identified above also mean that the processing work of the coffee GVCs, reflected in the soluble and roasted coffee exports, became more concentrated in certain countries over time? To obtain more insights in this regard, this section examines the distribution of the coffee

⁵ The analysis results based on the regional import statistics are not presented in figures in the study for the sake of brevity. They can be obtained upon request.

⁶ Our co-agglomeration analysis also shows that the export activities of green coffee are located closer to the very upstream part of the coffee GVC, namely the coffee bean production (harvest), while the production and exports of roasted coffee and soluble coffee need particularly imported coffee beans for further processing work along the coffee GVC. In addition, the co-agglomeration index calculated for each pair of the exports of the three coffee forms show that the pairwise co-agglomeration of exports among the three coffee forms further decreased over time.

export activities (by coffee form) across countries and its development over time. For this analysis, the generalized Theil index of concentration (see Bickenbach and Bode, 2008) is calculated as follows:

$$T = \sum_{i=1}^I \frac{\frac{X_i}{\Pi_i}}{\sum_{i=1}^I \frac{X_i}{\Pi_i}} \ln \left[\frac{\frac{X_i}{\Pi_i}}{\frac{1}{I} \sum_{i=1}^I \frac{X_i}{\Pi_i}} \right] \quad (1)$$

where $i = 1, \dots, I$ refers to the individual countries and X_i is the export activity considered. Π_i is a reference variable. In case of the absolute Theil index, the reference variable equals to one for all countries considered. In case of the relative Theil index, we use the country-level population statistics as reference to take into account countries' difference in size for analysing the concentration development over time. The minimum value of the Theil index is zero. In this case, each country's share in the economic activity is the same (absolute Theil) or is proportional to its population share (relative Theil). In other cases, the value of the Theil index is strictly positive, with an increasing value representing a higher level of inequality across countries.

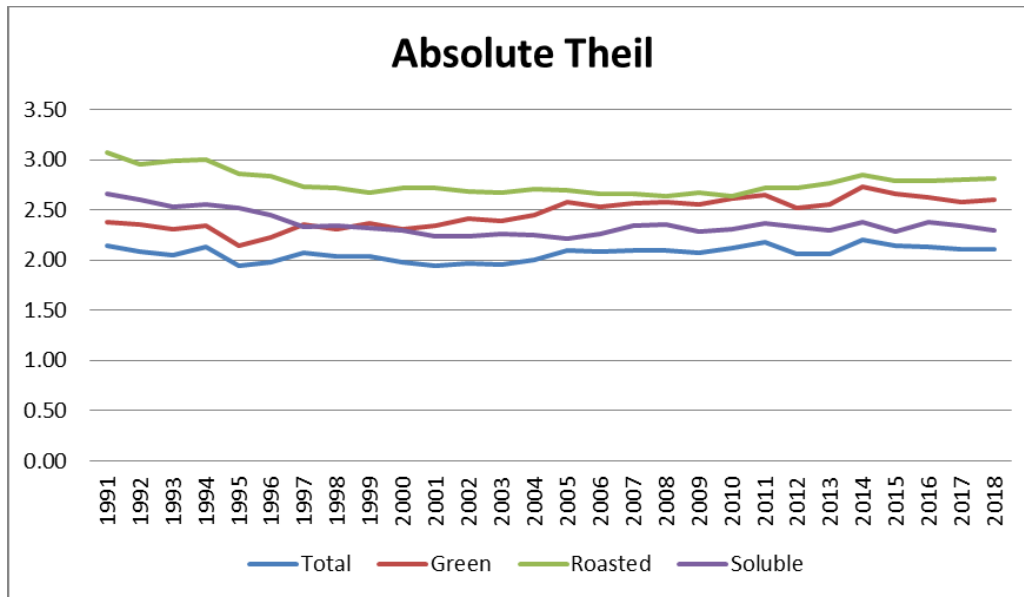
The analysis begins with the absolute Theil index and later moves to the relative Theil index to better take into account countries' different population size for discussion. In order to enable a comparison between the results based on the absolute Theil index and the relative Theil index, the analysis is carried out for a smaller group of 208 countries, for which the country-level population data are made available by the World Bank (World Bank, 2020a). Four export activities are considered, respectively: total coffee exports, green coffee exports, soluble coffee exports and roasted coffee exports.

Results of the absolute Theil index for the four types of export activities are presented in Figure 6. It shows that the total coffee exports were less concentrated among countries than the exports of each of the three coffee forms. This reflects the fact that the export activities for the three coffee forms tended to be concentrated in different countries. Comparing the three coffee forms, the concentration of the roasted coffee exports was higher than that of the other two forms of coffee. In other words, the production work for the higher value added roasted coffee exports tended to be concentrated in a smaller group of countries than that for the green coffee exports and the soluble coffee exports.

The concentration of roasted coffee exports actually decreased in the first years of the research period but rebounded slightly after 2008. A similar developing trend can also be observed for the soluble coffee exports, while the concentration of the green coffee exports increased almost continuously over the past decades. As a result, the concentration of the green coffee exports exceeded that for the soluble coffee exports since the beginning of the new century. Both of them remained less concentrated than the roasted coffee exports, however.⁷

⁷ The developments and the relative positions of distribution inequality for total exports and for exports of the three forms of coffee are hardly changed, if the full set of 240 countries are considered for the analysis. The only difference is that the levels of the concentration in case of the full country set are found to be higher than those in the subsample. This is, however, not surprising, considering the fact that most of the 32 countries included in the full list but not in the short list are oversea territories that are highly heterogeneous in terms of their resource endowment and societal and economic backgrounds.

Figure 6: Development of the concentration of coffee exports across countries over time (based on the absolute Theil index)



Source: ICO (2020b).

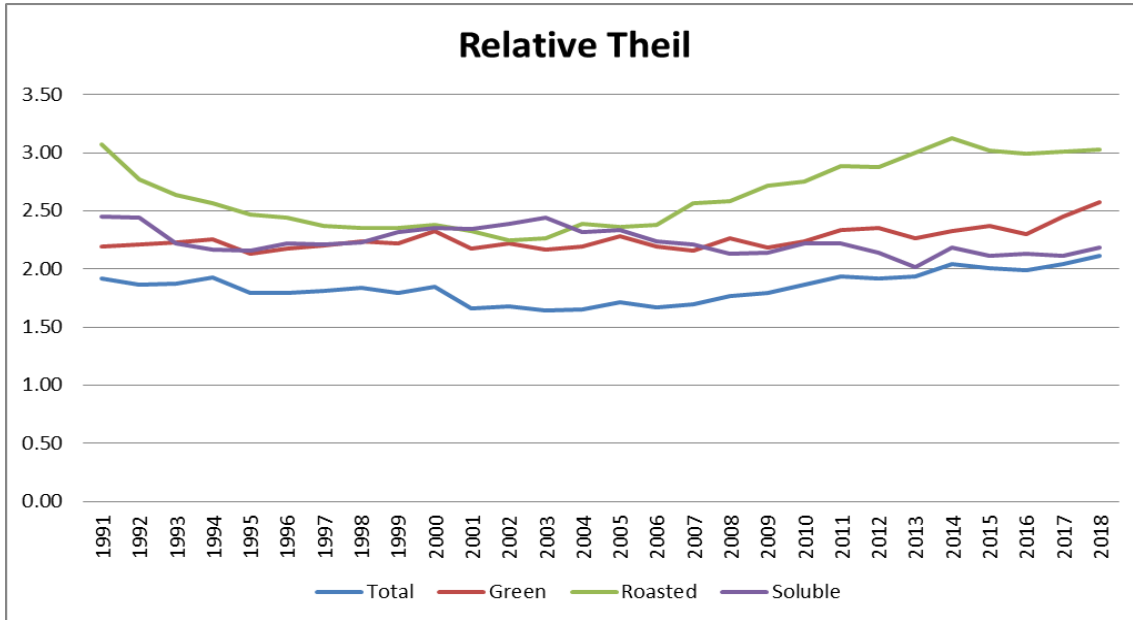
The analysis moves on to calculating the relative Theil index to take into account countries' difference in population size. Results are presented in Figure 7. It shows that the relative positions of the concentration levels of the total coffee exports and of the exports of the three coffee forms found in Figure 6 (absolute Theil) can also be generally observed in Figure 7. In most years considered, the concentration level of the roasted coffee exports was the highest and that of the total exports was the lowest, while the concentration level for the exports of the other two coffee forms lied generally in between.⁸ What is most different from the findings above is the much stronger increase in the relative concentration level for the roasted coffee exports since the beginning of the 21st century. The increase in the absolute concentration level for the roasted coffee exports occurred later and had a much weaker intensity.

These findings do not only show once again that the distribution of the roasted coffee exports was the most concentrated among the three coffee forms in general, but also show that concentration further increased over the past decade – both in the absolute and in the relative term. The particular strong increase in the relative concentration further indicates that the distribution of the roasted coffee

⁸ This indicates that also in terms of the relative Theil index the export activities of the three coffee forms tended to be concentrated in different countries. The analysis based on the Ellison-Glaeser co-agglomeration index (EG index, see Ellison and Glaeser, 1997; Ellison et al., 2010) using the country-level population share as the weight shows that the green coffee exports tended to be more concentrated in the countries where coffee production (harvest) took place. In contrast, the soluble coffee exports and the roasted coffee exports tended to be rather more strongly co-located in the countries with higher green coffee imports. The results of the co-agglomeration analysis are consistent with the findings based on the regional distribution analysis above (Section 2.3). These results again make it clear that the green coffee exports are closer to the very upstream part of the coffee GVCs, namely the coffee bean production (harvest), while the production and exports of the roasted coffee and the soluble coffee need particularly imported coffee beans for further processing work along the coffee GVC. In addition, the EG index calculated for each pair of the exports of the three coffee forms show that the pairwise co-agglomeration of exports further decreased over time. Technical information about the EG index is presented in the appendix (Box A1). The results of the co-agglomeration analysis are not shown in figures for the sake of brevity. They can be provided upon request.

exports across countries considered became much less proportional to their population shares over time.⁹

Figure 7: Concentration of coffee exports across countries over time (based on the relative Theil index)



Source: ICO (2020b) and World Bank (2020a).

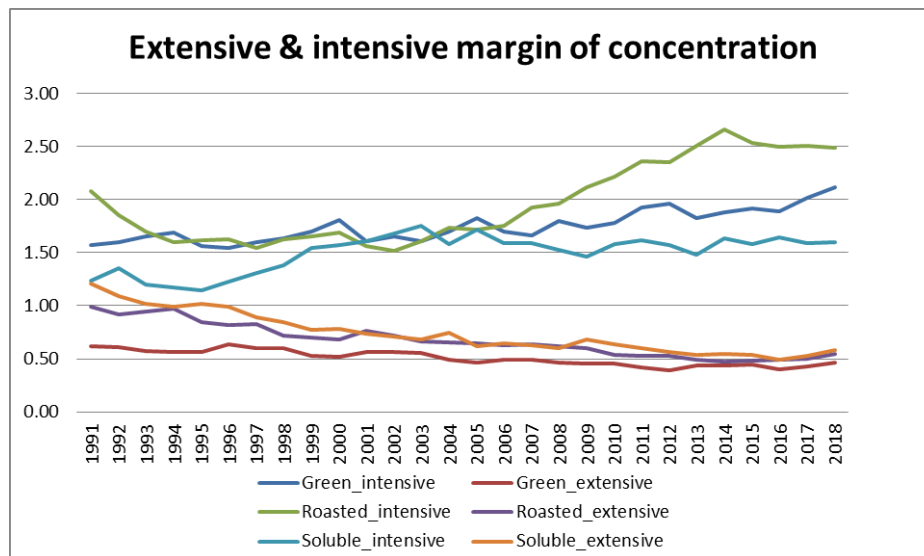
Using the decomposition characteristics of the generalised Theil index, the following analysis traces possible sources of the concentration development over time. The overall concentration can be, firstly, decomposed into two elements – extensive margin of concentration and intensive margin of concentration. The extensive margin of concentration basically reflects – in an inverse way – the share of countries involved in exporting activities considered, whereas the intensive margin of concentration measures the export concentration among exporters. For the case of the relative Theil, a lower extensive margin of concentration is determined by a declining population weight of countries with zero export values, while a lower intensive margin of concentration can be realised if the relative concentration of the export activities among countries with positive export values decreases.

As shown in Figure 8, the extensive margin of concentration for the exports of all three coffee types stayed at lower levels compared to the intensive margin of concentration and fell generally over time. In contrast, no continuous falling trend can be observed in case of the intensive margin of concentration. While the intensive margin of concentration for the roasted coffee exports and the green coffee exports fell or was relatively constant in the first years, they increased over the recent past decades. The increase was particularly prominent for the roasted coffee exports. In case of the soluble coffee, the

⁹ In other words, some countries did not just account for much higher or much lower shares of the roasted coffee exports than their population shares but the deviations also became larger over time. We further calculated the weighted relative Theil index, considering countries' population shares as weight (in addition to considering the population size as reference). The finding that the level of the weighted relative Theil index was lower than that of the unweighted relative index for the case of the roasted coffee exports in the recent past suggests that the deviations from the average roasted coffee export values per person are on average more pronounced in smaller countries. Country-level statistics further show that the concentration increase of the roasted coffee exports was mainly driven by smaller countries taking over disproportionately high shares of roasted coffee exports in relation to their population sizes (s. below).

intensive margin of concentration increased first and stayed at a higher level in the recent past than in early 1990s. These developments suggest that the population weight of countries with non-zero export values increased over time, implying that more people in the world can benefit from their countries being integrated into the coffee GVC. Since the population shares of countries did not change strongly over time, the increasing population weight was rather realised by the increasing number of countries involved in the coffee GVCs. This is also evidenced by the corresponding statistics.¹⁰ While more countries/inhabitants are now involved in the coffee GVC, the relative concentration across these countries (with positive export values) increased over time – especially in case of the roasted coffee exports followed by the green coffee exports in the recent past. This implies that while more countries/inhabitants are now integrated into the coffee GVC so that they can theoretically better reap the globalization benefits than before, the increasing concentration of coffee exports imply some challenges facing coffee exporters in order not to be marginalised in the coffee export markets.

Figure 8: Extensive and intensive inequality (based on the relative Theil indicator)



Source: ICO (2020a) and World Bank (2020a).

A second decomposition analysis focuses on examining whether the development of the overall concentration was mainly driven by the changes in the concentration within and/or between regions. The geographic classification with nine regions that was used above for the regional distribution analysis is used in the following analysis as well. The calculation results are presented in Figure 9.

Two development patterns are particularly worth mentioning. First, the within-region concentration played a more dominant role than its between-region counterpart for determining the level of the overall concentration for the green coffee exports and the soluble coffee exports in all years and for the roasted coffee exports since 2008. It played also a crucial role in determining the increasing concentration particularly in the case of the roasted coffee exports since the beginning of the new

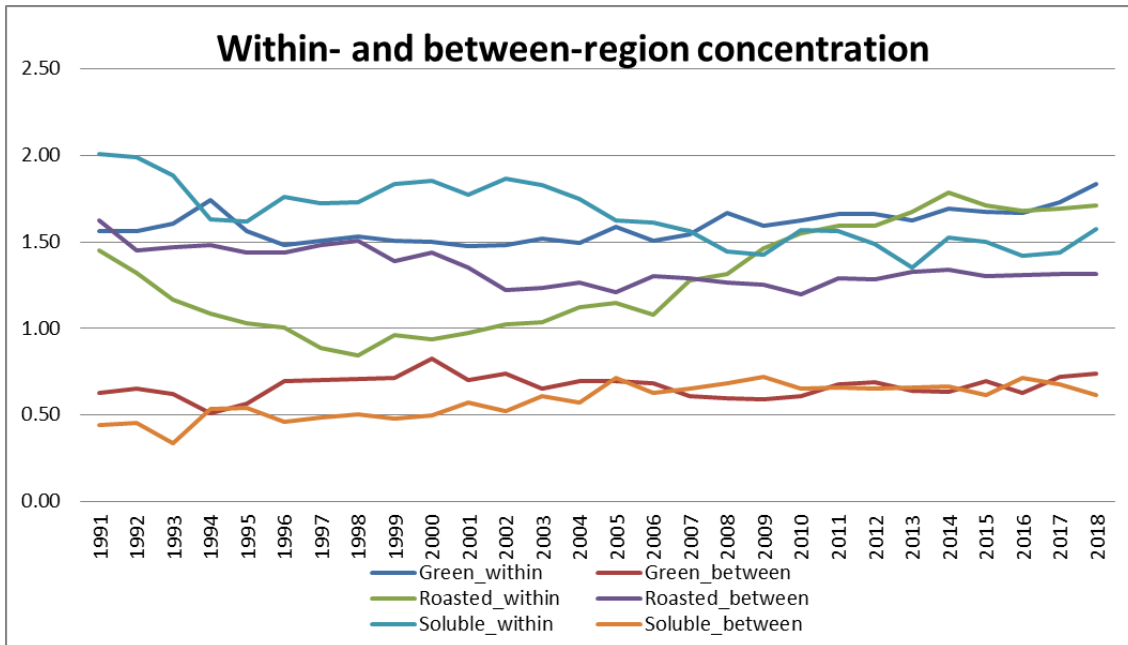
¹⁰ Statistics show that the number of countries that were involved in the coffee export activities indeed increased over time: from 131 to 145 (+11%) countries involved in the total coffee exports. The increase was even much stronger in cases considering the disaggregated exports by coffee form. The countries involved increased namely from 112 to 131 (+17%) for the green coffee exports, from 77 to 121 (+57%) for the roasted coffee exports and from 62 to 116 (+87%) for the soluble coffee exports.

century. Second, the between-region concentration generally decreased in the roasted coffee exports, while it slightly increased in the green coffee exports and the soluble coffee exports.

The finding that the between-region concentration tended to decrease for the roasted coffee exports is plausible, considering the finding from the regional distribution analysis above that showed an increasing share of Europe (non-EU) in roasted coffee exports over time at the cost of the market share of the traditionally dominant exporters, particularly the EU. On the contrary the finding that the between-region concentration increased slightly for the soluble coffee exports is less plausible at first sight, since the market share redistribution at the cost of the EU’s dominance can be observed here as well. Different from the former case, the decrease of the EU’s share was less substantial in the latter case, however, and there was a particularly strong loss in the corresponding market share of Africa where the population share actually increased. All these factors led to a slightly increasing between-region concentration in case of soluble coffee exports at the end. Despite, the between-region concentration stayed much lower than its within-region counterpart over time.

Although more countries became (more intensively) involved in the coffee GVC than before, the finding of the high levels of the within-region concentration for the exports of all three coffee forms and its particularly strong increase for the roasted coffee exports in the recent past still raises some concerns. It implies that the GVC integration promotion seems to have its limitation in encouraging a more equal involvement of different countries in the same regions in coffee production and export activities, particularly in the processing work and exports of roasted coffee.

Figure 9: Within- and between-region inequality (based on the relative Theil indicator)



Source: ICO (2020a) and World Bank (2020a).

The index of the within-region concentration is a weighted sum of the nine regions’ concentration indices of the export activities considered. For this reason, a further decomposition of the within-region concentration index enables to identify the driving forces of its development. In case of the roasted coffee exports where the within-region concentration increased most substantially, it is found that the increasing concentration of such export activities within Europe and within South America may play an

important role in this regard. There seem to be countries in these two regions that accounted for disproportionately higher or disproportionately lower shares of the roasted coffee exports of the region than their population shares and the disproportionality even increased over time.

A closer look at the country-level export statistics shows that the continuously successful market acquisition from Switzerland in Europe (non-EU) and Colombia in South America is likely the main reason behind the strongly increasing concentration within Europe (non-EU) and within South America, respectively. Switzerland's market share in the roasted coffee exports of Europe (non-EU) increased particularly in two periods, namely from 1995 (67%) to 2001 (96%) and from 2006 (88%) to 2018 (98%) (Figure 10), while its population share only slightly increased from 2.8% in 1991 to 3.6% in 2018. Such development determined the increase in the within-Europe concentration of the roasted coffee exports in these two specific periods accordingly. Switzerland's market expansion was highly likely attributed to Nestlé's innovation success in developing and marketing a new capsule-based way of premium coffee consumption. All coffee encapsulated and sold by Nestlé for the global market is roasted in Switzerland. The development of coffee capsules is a kind of product upgrading but it is also a sort of successful functional upgrading where Nestlé moved up the coffee GVC by carrying out innovation activities to create additional market value for its roasted coffee products.

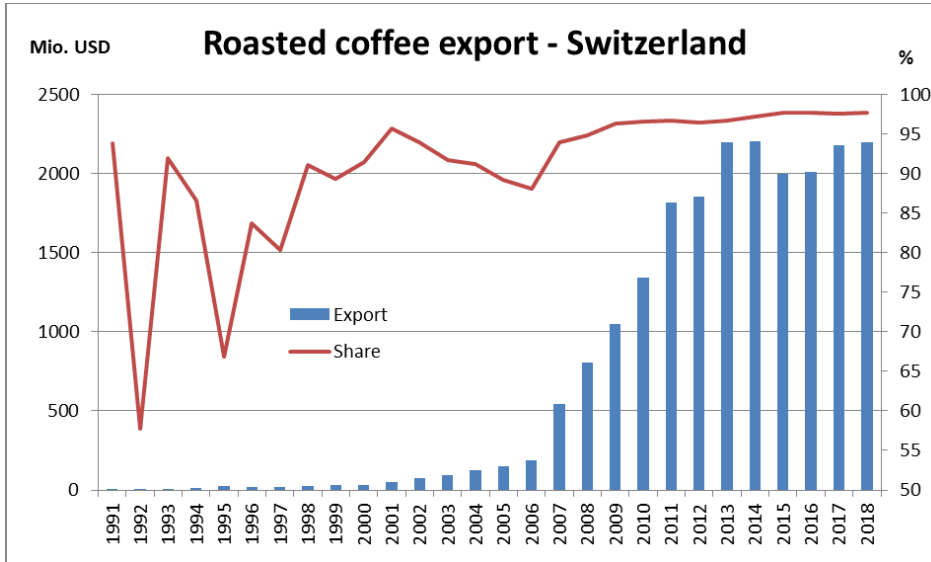
Colombia played a similarly determining role for the increasing concentration of the roasted coffee exports in South America. Its market share in the roasted coffee exports increased substantially (from 2% of the roasted coffee exports of South America in 1991 to 83% in 2018), while its population share stayed almost constant (11.2% – 11.7%) over time. The strong market expansion can be observed particularly in early 1990s and since 2007 (Figure 10). Different from Switzerland, Colombia is a coffee growing country and it is well-known for its high-quality Arabica coffee beans. Its success in roasted coffee exports indicates that Colombia also made progress in functional upgrading, i.e., it has moved up the coffee GVC by carrying out more roasted coffee processing work than before.

While increasing concentration of the roasted coffee exports both within Europe (non-EU) and within South America may play an important role for the strong increase in the overall within-region concentration of the roasted coffee exports (Figure 9), the influence of Europe (non-EU) was much larger than the of South America in this regard. This was attributable to the much stronger increase in Europe's (non-EU) share in the roasted coffee exports over the same period (from 0.4% in 1991 to 23% in 2018) that as a key element further raised its weight considered in calculating the index of the within-region concentration. The strong increase in the within-Europe concentration in the roasted coffee exports over time thus further determined the strong increase in the overall concentration of the roasted coffee exports (Figure 7) in the research period.

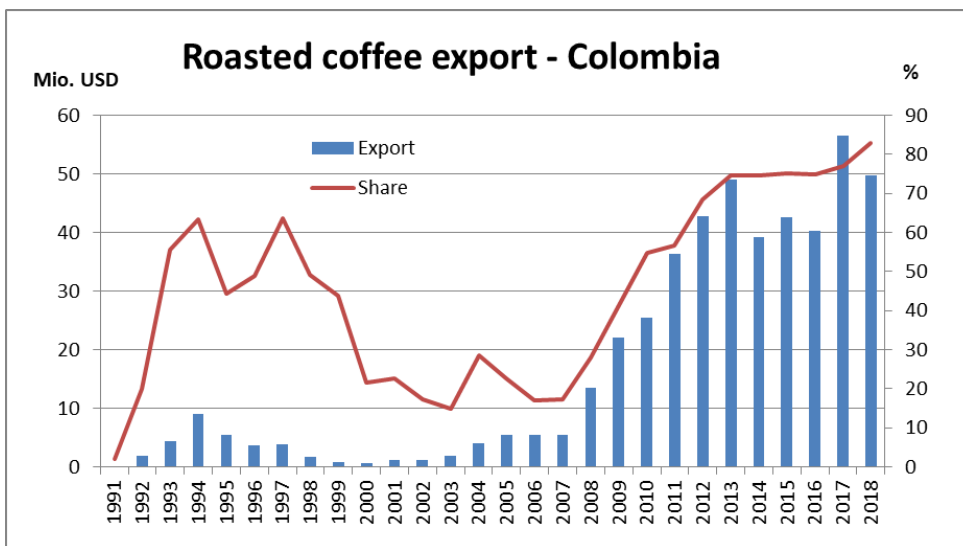
Countries which acquired increasingly disproportionately larger market shares in the roasted coffee exports are the countries that became more successful in taking over the related coffee processing work for acquiring higher added value for the products in the coffee GVC. Increasing concentration of such processing and export activities in specific countries raise questions of why these countries seem to be more successful in functional upgrading and thus to be more capable of taking over such processing work than others.

Figure 10: Roasted coffee exports of Switzerland and Colombia

(a) Switzerland



(b) Colombia



Notes: The shares refer to the share of Switzerland’s (Colombia’s) roasted coffee export in the roasted coffee export in non-EU Europe (South America).

Source: ICO (2020b).

2.4.2 Involvement in trade via product upgrading

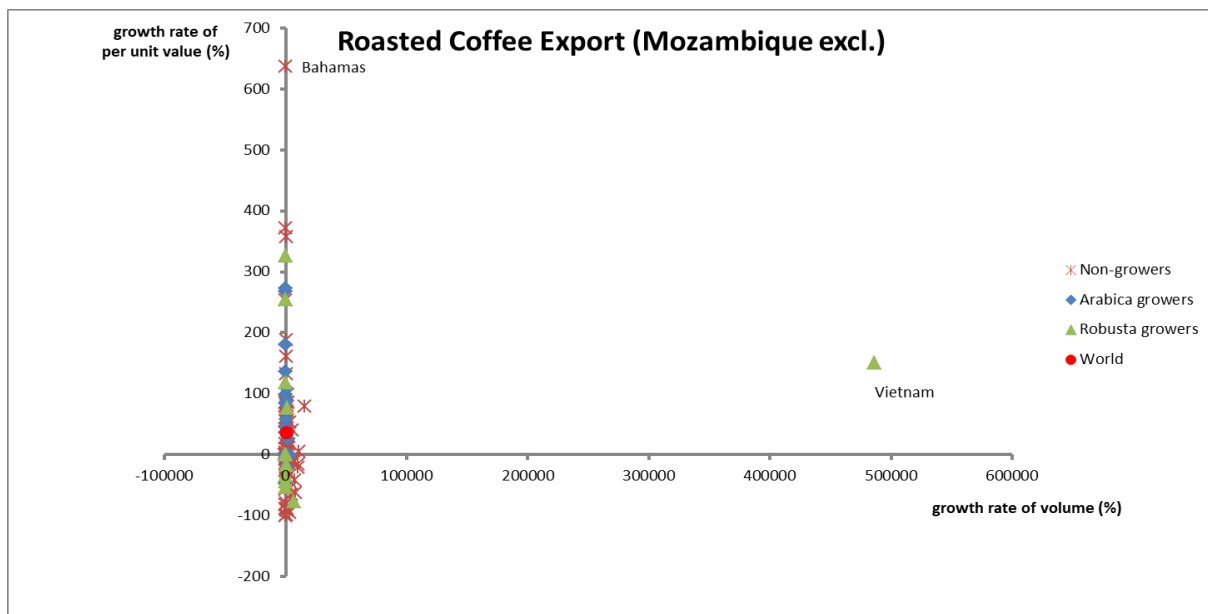
Functional upgrading is one way that countries may take to carry out more processing work in the coffee sector and thus to acquire a larger share of the value added created in the coffee GVC. Another way that can support countries to benefit more from value added created is product upgrading. Assuming that successful product upgrading improves the product quality and thus enables exporters to set higher prices, the analysis in Section 2.2 suggests that such product upgrading may have been particularly successful in the case of exported roasted coffee. While positive price development is also observed for exported green coffee (particularly those exported by Arabica growers), the price increase was much weaker there than for roasted coffee exports. In case of the soluble coffee exports, the price

development is found to be generally negative. Such developments raise the question, whether all countries involved in the related export activities have been equally successful in the corresponding product upgrading? If not, which countries were particularly successful in this regard?

In case of roasted coffee exports, most countries were able to expand their export volume over time, but not all of them were able to increase their product value over the same period (Figure 11). Vietnam can be clearly identified as a market winner that was able to expand its export volume of roasted coffee substantially and was also able to achieve a higher price for their roasted coffee in the recent period (2015–2018) than in the early 1990s. So did Switzerland, where the two growth rates of both prices and volumes were smaller than Vietnam, however.¹¹ In contrast, countries such as Czech Republic, Malaysia and Belize expanded their export volume of the roasted coffee but failed to achieve higher prices for their products in the recent past.

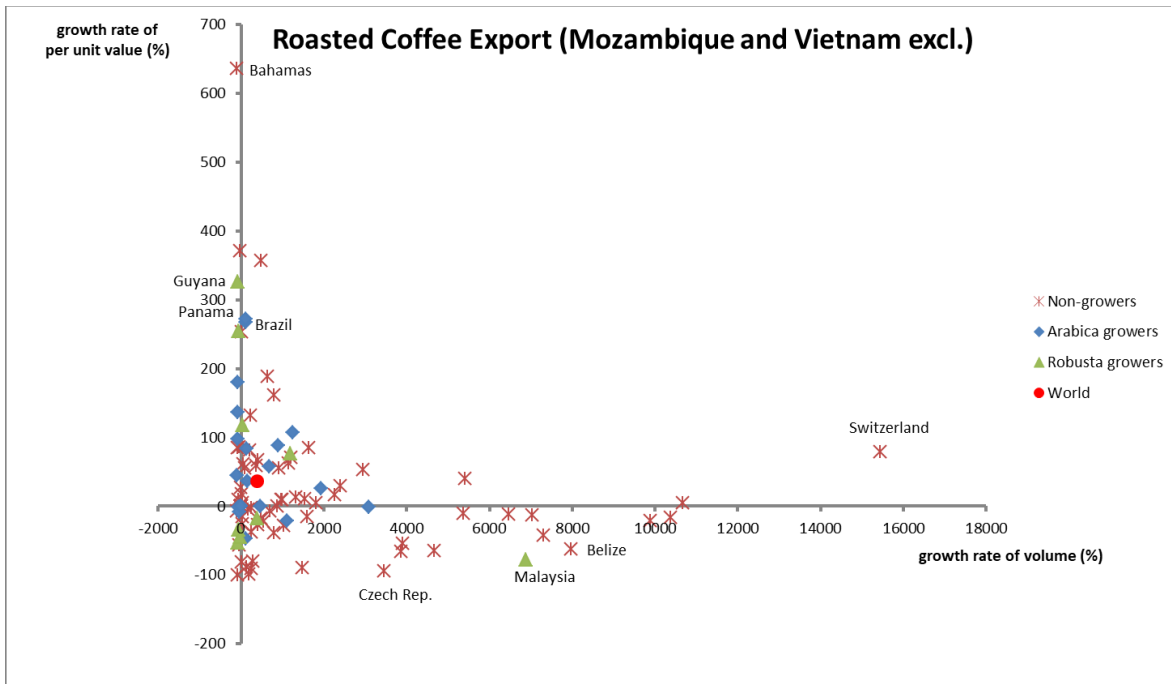
Figure 11: Growth rate of per unit value vs. growth rate of volume between the recent period (2015–2018) and the first period (1991–1994) in case of roasted coffee exports (both in %)

(a) All countries involved in roasted coffee exports in both year periods considered except for Mozambique



¹¹ Mozambique was actually the country that enjoyed the strongest price increase in exported roasted coffee, where the volume of roasted coffee sold decreased by almost 99% in the most recent period. Mozambique with its growth rate of price as high as 1037804% is not shown in the figure mainly for two technical reasons. First, the finding that the growth rate was overwhelmingly high, while the export volume was quite low raises some concerns about the reliability of Mozambique’s export data. Second, showing Mozambique in the figure makes the figure much less informative.

(b) All countries involved in roasted coffee exports in both year periods considered except for Mozambique and Vietnam



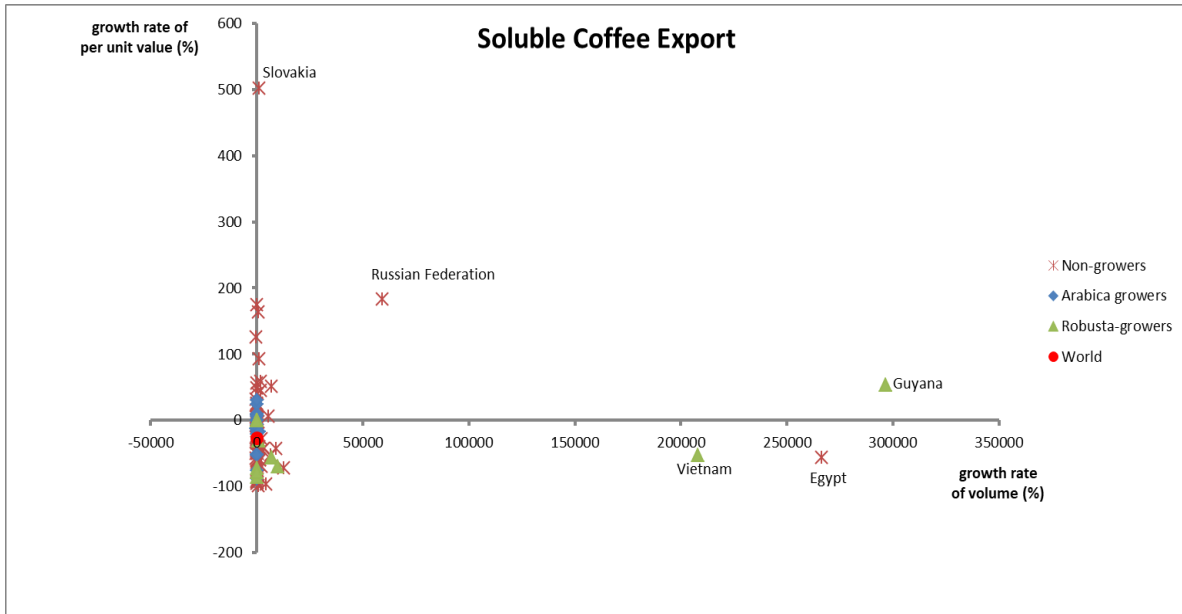
Notes: The growth rate of price is calculated in the same way as in Figure 3. Arabica (Robusta) growers are countries which, according to coffee production statistics, harvest coffee beans and their harvest is mainly Arabica (Robusta) coffee.

Source: ICO (2020b).

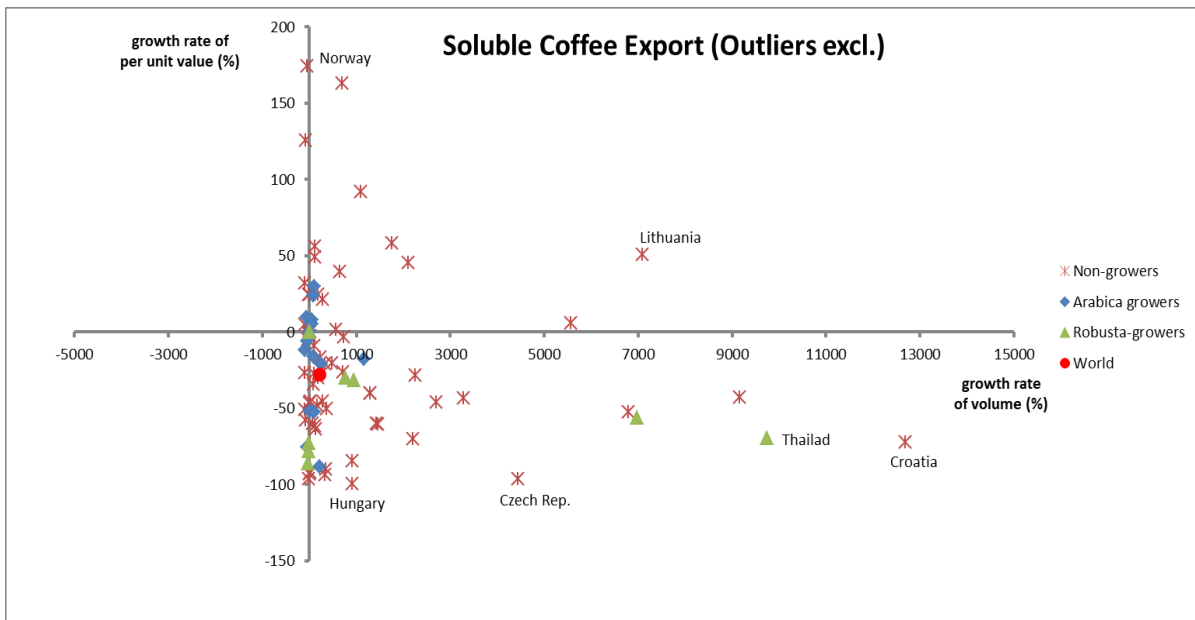
The finding above that countries faced different price developments is also observed in the case of the soluble coffee exports. In line with the generally negative price development in exported soluble coffee, most countries involved experienced lower product prices in the recent past than before, while they expanded their export volumes over time (Figure 12). Interestingly, Vietnam can be clearly identified as one of the exceptional cases here as well. But different from the price increase observed in its exported roasted coffee, the export price of Vietnam’s soluble coffee decreased strongly over time. Egypt experienced a comparable price fall, while its export volume expanded even more strongly than Vietnam. Despite the generally negative price development in the soluble coffee exports, there were still some countries whose soluble coffee enjoyed higher prices in the export market today than in the early 1990s. Slovakia and Russia were the two countries that realised the strongest price gain over time. Such development with increasing exports in volume but decreasing prices can be on the one hand a result of countries’ failure in product innovation to improve coffee quality to raise product value but can on the other hand be a result of a strongly expanding supply of the soluble coffee in the global market that can be, for example, driven by an increasing number of soluble coffee providers worldwide and/or supported by the more advanced technologies used in the production that enhanced production efficiency.

Figure 12: Growth rate of per unit value vs. growth rate of volume between the recent period (2015–2018) and the first period (1991–1994) in case of soluble coffee exports (both in %)

(a) All countries involved in soluble coffee exports in both year periods considered



(b) All countries involved in soluble coffee exports in both year periods considered except for outliers (Egypt, Guyana, Russia, Slovakia and Vietnam)



Notes: The growth rate of price is calculated in the same way as in Figure 3. Arabica (Robusta) growers are countries which, according to coffee production statistics, harvest coffee beans and their harvest is mainly Arabica (Robusta) coffee.

Source: ICO (2020b).

While the non-grower exporting countries dominated in processed coffee exports, particularly the roasted coffee exports, coffee growers were mainly engaged in green coffee exports. In light of this, if certain coffee growers did realise significant product upgrading and thus were able to increase their product value, this is expected to be reflected in their green coffee exports.

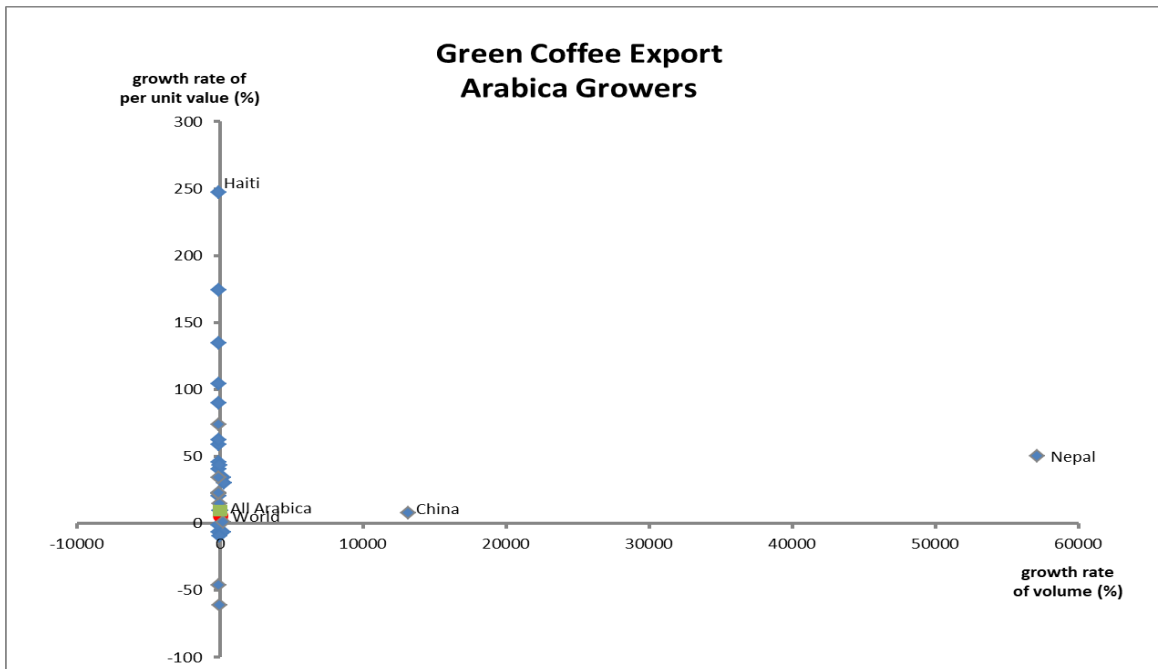
Figure 13 and 14 indeed show that most coffee growers were able to request higher prices for their exported green coffee in the recent past compared to the early 1990s. Moreover, relatively more Arabica growers succeeded in requesting higher prices for their exported green coffee in the recent past than Robusta growers. What is different from the findings above is that many of these coffee growers exported less in volume nowadays than before.

It is possible that some of these coffee growing countries cultivated and harvested less coffee than before in general, while paying more attention to improving the quality of their coffee beans in order to achieve higher prices. It is, however, also possible that some of them just kept a larger share of their green coffee with now improved quality at home for own coffee processing work, thus reducing their green coffee exports over time. Since many coffee growers decreased their production volumes in the recent past according to the coffee production statistics, the first explanation seems to be more relevant here.

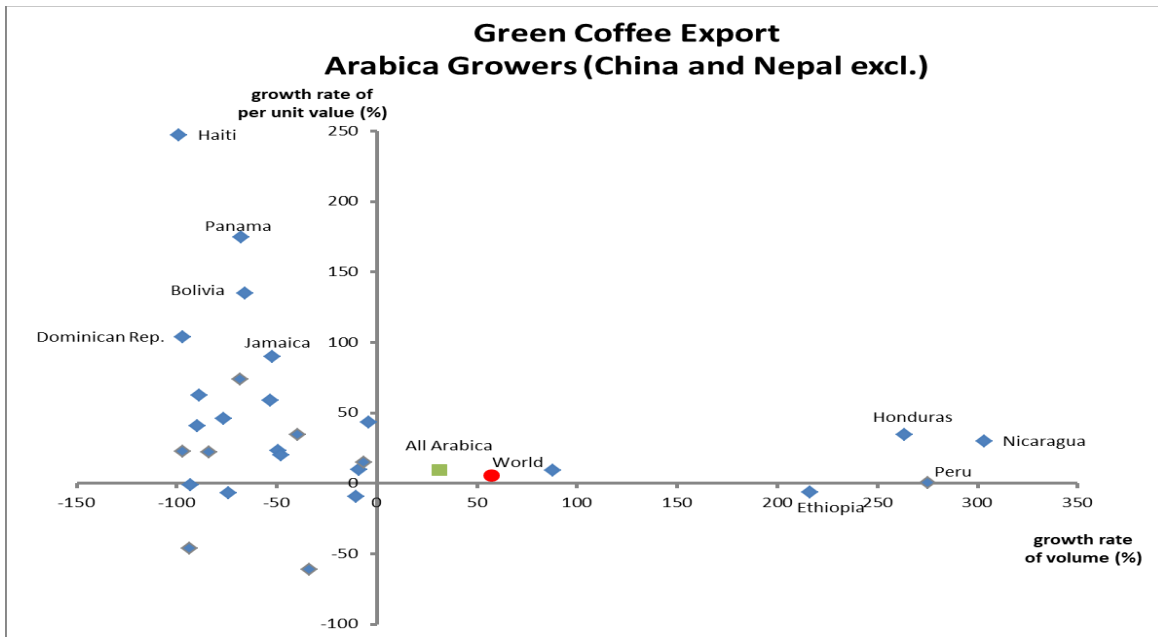
Vietnam again is identified as one of the exceptional cases. As a coffee grower with Robusta coffee as its main coffee beans harvested, it gained most among Robusta growers in the exported volume of green coffee. At the same time it was faced with a falling price challenge with only two countries (Guinea and Democratic Republic of Congo) having suffered more intensively than Vietnam. Among the Arabica coffee growers, Yemen experienced the largest price fall for their exported green coffee.

Figure 13: Growth rate of per unit value vs. growth rate of volume between the recent period (2015–2018) and the first period (1991–1994) in case of green coffee exports by Arabica growers (both in %)

(a) All Arabica growers involved in green coffee exports in both year periods considered



(b) All Arabica growers involved in green coffee exports in both year periods considered (except for China and Nepal)

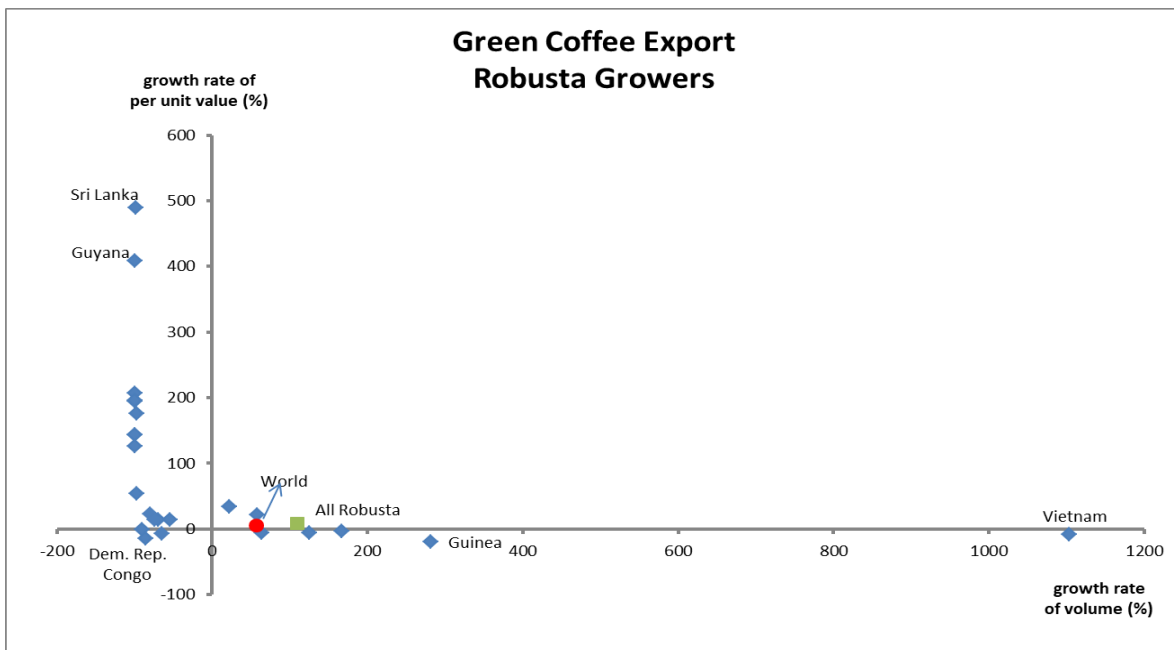


Notes: The growth rate of price is calculated in the same way as in Figure 3. Arabica (Robusta) growers are countries which, according to coffee production statistics, harvest coffee beans and their harvest is mainly Arabica (Robusta) coffee.

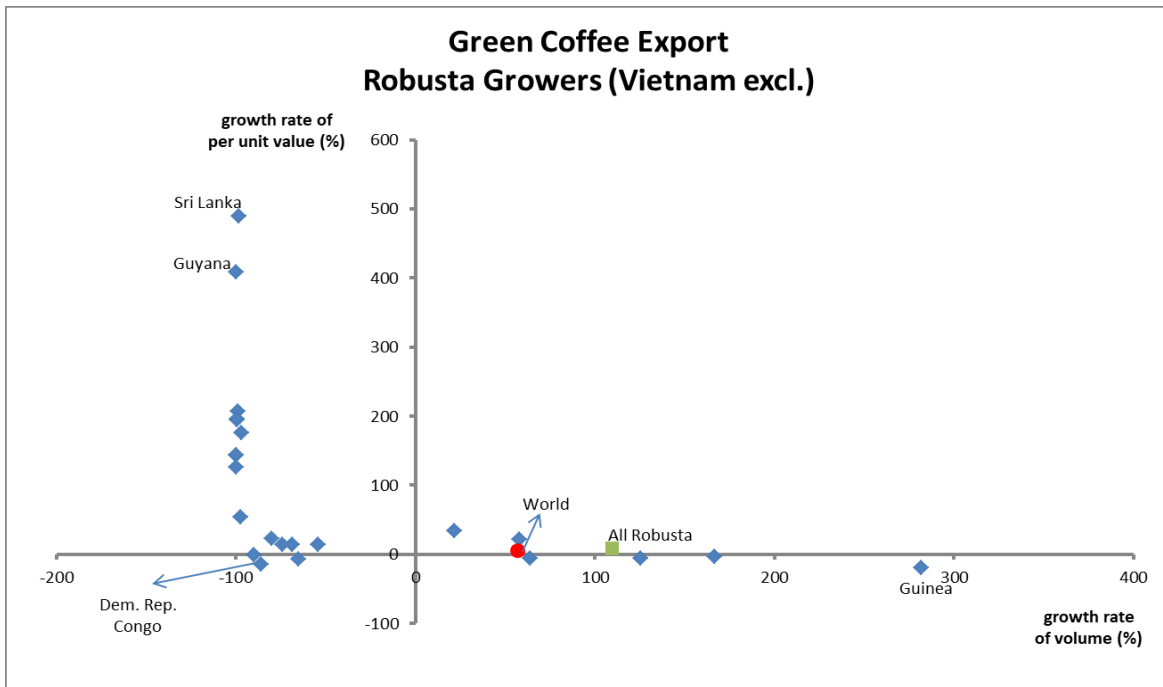
Source: ICO (2020b).

Figure 14: Growth rate of per unit value vs. growth rate of volume between the recent period (2015–2018) and the first period (1991–1994) in case of green coffee exports by Robusta growers (both in %)

(a) All Robusta growers involved in green coffee exports in both year periods considered



(b) All Robusta growers involved in green coffee exports in both year periods considered (except for Vietnam)



Notes: The growth rate of price is calculated in the same way as in Figure 3. Arabica (Robusta) growers are countries which, according to coffee production statistics, harvest coffee beans and their harvest is mainly Arabica (Robusta) coffee.

Source: ICO (2020b).

The analysis in Chapter 2 clearly shows that some countries were more successful than others in being integrated into the coffee GVC through joining the coffee exporting activities, through functional upgrading along the coffee GVCs and/or through product upgrading in the past decades. This raises further questions of why some of them were more successful than others and what the main determinants of their GVC integration were?

3 Determinants of coffee GVC participation

3.1 On the advantages of GVC integration with focus on the coffee industry

As described in Chapter 1, the coffee industry is characterised by oversupply, depressed prices, poor incomes, inadequate investment and low productivity of growers (ICO, 2019). There is an obvious route out of this underinvestment and poverty spiral. This is where GVCs can play a role. Additional industry gains may be achieved by boosting value added, thereby raising investment and improving productivity. We briefly sketch the arguments for how these problems can be fixed, through the actions of GVCs and the freedom of upstream participants (e.g. growers) to capture value added.

On an intuitive level, we can understand why coffee growers might want to formalise more binding contracts with coffee processors. Studies in the literature provide additional evidence why such long-term contracts (integration into GVCs) is beneficial. Contractual commitments between different agents in a production chain are often but not necessarily accompanied by knowledge transfers between agents in the chain (Görg et al., 2018; Alfaro and Charlton, 2009). These long-term commitments can

benefit in other ways. Contractual agreements between buyers and sellers can help to circumvent (or altogether avoid) the short-run production and demand shocks that accompany fluctuations in the commodity markets. In the most extreme case, these contractual agreements can take the form of vertical integration, where production is fully conducted in-house by a multi-plant enterprise. In the case of the coffee industry, this would suggest a merger between e.g. a syndicate of growers and the coffee roasting/branding enterprise.

Apart from helping to smooth over demand shocks, there is a further reason for contractual commitments between e.g. growers and processors. They can help to reduce transaction risk between participants in the value chain. In so doing, integration into GVCs helps value chain participants to raise bank credit. Alternatively, other forms of finance such as equity can be raised. Overall, the injection of capital is expected to raise productivity. The latter receives a positive boost from closer integration into GVCs.

Finally, there is a further advantage of locking into GVCs. Where growers work more closely with processors, the revenues can get distributed more equally along the coffee chain. At a country-level, a higher fraction of revenues from overall coffee production can be appropriated by stakeholders (growers and processors) within the coffee producing country. This happens if integration takes place between domestic growers and domestic (or foreign-owned) processors within the coffee growing country. Growers and processors within the same “neighbourhood”, separated only by a short distance, are more likely to exchange ideas and work more closely towards streamlining production (Ellison et al., 2010). The result is a pareto improvement in average coffee revenues – both in coffee producing countries and importing countries. This result is however, conditional on certification, consumer willingness to pay and other factors which we will elaborate on later. More generally, the coffee industry would be better positioned to meet the United Nations call for increasing exports from developing countries, particularly the least developed countries (Target 17.11) (UN, 2020). This appeal for increased exports from developing countries has direct relevance for exchanges within the coffee industry, especially for the revenues of growers. It also underpins the necessity to formalise these exchanges – to allow growers to lock into the vertical production chain.

Having outlined the case for GVC integration, we now turn to our core research questions in this chapter. Up to now, about 70 percent of unprocessed (green) coffee is exported (ICO, 2019). Accordingly, little processing takes place within coffee growing countries. For this reason, value addition remains concentrated in green coffee importing countries like Germany, Italy and Switzerland. But there is considerable variation across coffee growing countries. This variation suggests that some countries are better able to capture value from their basic coffee production. This cross-country feature of the data allows us to exploit the cross-country (and time) variation in an attempt to understand which environmental conditions support the winners (and hinder the losers), in the effort to extract value from coffee processing. Our research questions in this chapter can be formulated as

- Which factors drive the processed component of coffee imports and exports of countries?
- Which factors enable countries to functional upgrade the share of coffee exports – where functional upgrading is measured as the proportion of processed vs green coffee?

Additionally, as presented in Section 2.2 and Section 2.4 there is price variation for green coffee depending on the variety or/and the quality, e.g. Arabica vs. Robusta and hand-picked vs. mechanised

coffee harvesting. Accordingly, we further analyse the factors which drive product upgrading within the green coffee value chain.

The coffee industry poses fewer challenges than some others, with regard to assessing the extraction of value added from green coffee. The production chain is relatively straightforward from the raw product towards processed soluble and roasted coffee. When designing a methodological framework for the analysis, we reference similar studies in the literature (see Fernandes et al., 2020). Although none of these existing studies are focused specifically on the coffee industry, they can serve as a roadmap. There is a wide range of possible factors we can consider in our analysis such as factor endowments, geography, FDI, trade policy (tariffs), domestic industrial capacity, institutional quality and macroeconomic factors. Related studies (e.g., Fernandes et al., 2020) that discuss the dynamics of GVCs, group the different factors under these broad headings. We should point out that we carefully tried to adjust all domains to the coffee industry. Moreover, we consider coffee related factors such as the domestic consumption of coffee.

We organise our analysis of the determinants of GVC integration in the following way. In Section 3.2 we propose three indicators to measure countries' GVC integration for the coffee industry. Section 3.3 introduces the empirical methods and the data we use. Here we describe the different information we compile from a variety of sources, supplementing the data made available to us by the ICO (ICO, 2020b). In Section 3.4 we report the results of our regression analysis, followed by a brief summary.

3.2 Indicators of GVC integration

In this section we elaborate on a few key concepts, illustrating how we can translate these concepts into variables to measure countries' integration into the coffee GVC.

The first concept is value-added in the production chain. We describe in Section 3.1 how the coffee production chain is relatively non-complex, with besides some possibilities to improve product prices of green coffee, the overwhelming share of the value-added taking place in the green coffee importing country. Nevertheless, there is much variation between coffee producing and importing countries in terms of the share of green coffee that gets processed. It is precisely this variation we want to exploit – leveraging this feature of the data in helping to explain why some coffee growing countries seem relatively successful in capturing value added by building up a processing industry. Consider a coffee exporting country which dedicates a certain land area to growing coffee. Consider also an industrialised country, which imports green coffee and specialises in downstream stages of the production chain. In the case of forward integration, the coffee growing country manages to capture higher value from its green coffee production through taking over production processes that have been traditionally conducted in the industrialised country. By forward integration, we mean the process whereby e.g. a consortium of coffee growers would, through targeted investment, conduct their own roasting, packaging, branding and distribution. By extension, the process can work the other way around – a coffee processor integrating with a consortium of coffee growers. Either way, if the combined output is produced domestically (e.g. gets reported as sales from a coffee growing country like Honduras or Guatemala), the result is higher value-added in the sales statistics. Additionally, increased productivity of either participant in the value chain would also get recorded as higher value-added in the sales statistics.

To keep things simple, we consider three possible ways in which the coffee exporting country can add value to green coffee: First, a country can improve the quality of the green beans exported by product

upgrading, including selective picking by hand, introducing post-harvest processing such as washing or cultivating organic coffee. Second and third, it can participate in the coffee global value chain by functional upgrading and produce either, roasted or soluble coffee. Besides these forms, a higher value added to the final product can be reached by increased productivity, decreased overall costs and a corresponding increase of the gross margins of market participants. Unfortunately, the latter is not possible to monitor through classical trade statistics focusing on the revenues.

What follows is a more rigorous description of how to take the concepts of value added that we outlined above, mapping them to the available data. Specifically, we are interested in discovering which factors influence a country's GVC integration for the coffee industry. To this end, we cover alternative outcome variables focusing on exports, imports, functional upgrading and product upgrading. All measure different forms of integration into the coffee GVC. Additionally, we differentiate between total amount of sales from coffee production as well as different forms of coffee – namely green, soluble and roasted coffee. These outcome variables are extracted from the bilateral trade data provided to us by the ICO for the years 1991 to 2018 (ICO, 2020b).¹²

A key property of GVCs is that inputs of a final product may cross a border several times. Unfortunately, it is not possible to accurately track the progress of a coffee bean following its harvesting, right up to the point of time when the same quantity of coffee gets sold in supermarkets, restaurants or bars and at working places. However, we exploit the sequential character of the coffee value chain. Green coffee provides an input for both soluble as well as roasted coffee. Seldom is it directly sold to final consumers. Accordingly, imported green coffee serves as an input which requires further processing, either as soluble or roasted coffee. We argue that when a country imports green coffee, its primary objective is to conduct further processing. Indeed, from our regional trade analysis of in Section 2.3 and the co-agglomeration analysis in Section 2.4, we have preliminary support for this conjecture.

For this reason, we interpret high imports of green coffee as backward GVC integration (see earlier discussion). In other words, a high value of green coffee imports relative to total coffee imports, suggests the integration of coffee processing stages in the recipient country (e.g. Germany, USA, Switzerland or Italy).

Additionally, we use the sequential nature of our three available coffee forms (green, roasted, soluble) to create a measure designed to capture functional GVC upgrading. Soluble and roasted coffee represents a processed form of green coffee. Accordingly, the distance to the final consumer is reduced. We can interpret this reduced distance to the end-customer, inferring that roasted coffee and soluble coffee occupy downstream positions within the coffee GVC. As described in the Introduction (Chapter 1), only around \$20 billion of the estimated annual revenue of the coffee industry (more than \$200 billion) are appropriated by the world's coffee growing nations and the main value of the annual revenue is generated by sales of processed coffee. Accordingly, we interpret a higher share of exports in soluble and roasted coffee (from any given coffee producing country), as indicative of functional upgrading, including a higher domestic amount of value-added. In an additional analysis, we focus on coffee growing countries to consider that coffee growers show higher levels of exports of green coffee and have lower values of functional upgrading compared to non-growing countries. Moreover, we analyse the determinants of product upgrading within the green coffee value chain and analyse the driver of higher received export revenues per unit sold.

¹² Since our independent variables are not available for the complete period, we limit our analysis to the period 1995–2018.

3.3 Empirical model and data

Empirical model

In our econometric approach, we use a modified form of the Fernandes et al. (2020) framework that was also applied by IBRD and the World Bank for the GVC participation analysis in the World Development Report 2020 (IBRD & World Bank, 2020), in order to apply it to the coffee GVC. The distribution of coffee imports and exports follows a Poisson distribution without negative values. Accordingly, we decided for the Poisson Pseudo-Maximum-Likelihood Estimator (PPML) (Santos Silva and Tenreyro, 2006). However, our measure of functional GVC upgrading does not similarly follow a Poisson distribution. Relative exports of different forms of coffee are highly skewed. As analysed in the prior section, exporting activities (green, soluble, roasted) tend to be located in different countries. Consequently, many countries export high shares of processed coffee and only small amounts of green coffee. Alternatively, we include an additional specification only focusing on coffee growing countries, which again follows a Poisson distribution. Our general specification can be formulated as:

$$Y_{it} = \alpha + X'_{it}\beta + \delta_t + u_{it} \quad (2)$$

with Y_{it} is the dependent variable measuring GVC integration of country i at time t . This includes single specifications on the coffee imports, exports and GVC upgrading. Applying PPML does not require any transformation of the dependent variable (such as taking the natural logarithm) and accordingly also includes observations where the dependent variable equals zero. For all variables we apply 4-year averages. Our reasoning for applying the average is that it firstly reduces the possibility of noise introduced by outliers. Second, some of the independent variables are unavailable for some years. Accordingly, this adjustment to the data avoids the loss of observations. Nonetheless, we do not have full coverage for all independent data for the period 1991–1994. For this reason we focus on six periods between 1995 and 2018.

The vector X_{it} comprises a vector of potential determinants of the GVC participation (our independent variables), δ_t are period fixed effects, and u_{it} is an independent and identically distributed error (i.i.d.). We now describe the different determinants we capture in our empirical analysis in greater detail.

On the determinants of coffee GVC integration

Our next task is to finalise a list of variables which other studies have found useful in helping to explain the extent of value added within an industry. We use a similar taxonomy to Fernandes et al. (2020) who have pioneered the most influential study in the empirical investigation of GVC integration. However, the latter study does not focus on a specific industry. For this reason, we adjust the approach applied in the Fernandes et al. (2020) study, applying the empirical framework to the patterns in the coffee sector. Overall, Fernandes et al. (2020) covers several different domains, each of which captures variables helping to explain integration into GVCs. We recall that these domains are – factor endowments, geography, FDI, trade policy (tariffs), domestic industrial capacity, institutional quality and macroeconomic factors. We cover these domains and some additional coffee-specific domains, collecting several groups of independent variables. These are summarized in Table 2 and discussed in the next part.

Table 2: Description of independent variables and sources

| Variable name | Description | Source |
|--|---|---|
| (ln) resource rents/ Gross domestic product (GDP) | Total natural resources rents (% of GDP) (NY.GDP.TOTL.RT.ZS) | World Bank (2020a) |
| (ln) capital / GDP | Capital stock at constant 2011 national prices (in mil. 2011USD) in relation to GDP (constant 2010 USD) | University of California, Davis and University of Groningen (2019) and World Bank (2020a) |
| (ln) arable land / GDP | Normalized arable land area in 1000 ha in relation to GDP (constant 2010 USD) | FAO (2020) and World Bank (2020a) |
| (ln) distance to processing hubs | Average distance of the capital of Germany, USA and Italy | CEPII (2020) |
| (ln) domestic industrial capacity | Manufacturing, value added (% of GDP) (NV.IND.MANF.ZS) | World Bank (2020a) |
| Tariffs rate (primary) | Tariff rate, applied, weighted mean, primary products (%) (TM.TAX.TCOM.WM.AR.ZS) | World Bank (2020a) |
| (ln) FDI inflows | Foreign direct investment: Inward flows | UNCTAD (2020c) |
| Political Stability Index | Political Stability and Absence of Violence/Terrorism: Estimate (PV.EST) | World Bank (2020b) |
| Depreciation | Official exchange rate (LCU per USD, period average) | World Bank (2020a) |
| (ln) GDP p.c. | GDP (constant 2010 USD) and Population, total (SP.POP.TOTL) - UNIT | World Bank (2020a) |
| (ln) Population | Population, total (SP.POP.TOTL) - UNIT | World Bank (2020a) |
| (ln) consumption p.c. in kg | Consumption per capita based on ICO statistics | ICO (2020b) |
| Coffee growing country – Arabica dominates (dummy) | A dummy if the country reported any production of coffee and Arabica dominates | ICO (2020b) |
| Coffee growing country – Robusta dominates (dummy) | A dummy if the country reported any production of coffee and Robusta dominates | ICO (2020b) |

Factor endowments

Top of the list is factor endowments. We cover three different domains of factor endowments, namely (1) natural resources, (2) capital and (3) arable land. Natural resources are denoted by the natural logarithm of rents from resources scaled by gross domestic product (GDP). An abundance of natural resources (e.g. petroleum or copper) is closely linked to forward GVC integration, because agricultural products and commodities are used in a variety of downstream products (Fernandes et al., 2020). However, because we are zeroing in on the coffee GVC, we expect another effect to dominate. This effect is the famous Dutch Disease phenomenon. A country abundant in natural resources such as petroleum might face the Dutch Disease, as labour flocks to the petroleum sector, bidding up the prices of labour in other industries. Also, the dominance of the petroleum sector might bid up currency prices, making it more difficult for exporters in other sectors to compete. Accordingly, agricultural products such as coffee might be adversely hit by a burgeoning trade in natural resources. It follows that natural resources may crowd out the coffee processing industry, marginalising the industry, reducing the component of domestic inputs in the value of exports from this sector. In our regression results, we expect negative signs for specifications on exports, imports, functional upgrading and product upgrading. An expected negative impact on GVC upgrading is the direct effect of a crowding out of coffee processing industry.

Additionally, we measure capital endowment, using the natural logarithm of capital over GDP. Capital endowment is especially important for the sections of the processing industry located further downstream in the value chain (Fernandes et al., 2020). In line with this, we expect that our specifications for processed coffee are driven by capital endowments. The relevance of this variable is

expected to be less predominant for green coffee, which is still mainly harvested by smallholder farmers. However, we also investigate the drivers of product upgrading in the green coffee value chain where we also expect a positive effect.

Land endowment is measured by the natural logarithm of arable land in 1000 ha over GDP. However, our expectations for the direction and magnitude of this effect are not clear-cut. Many small countries are exporters of green coffee. However, large countries also have more land available for cultivation.

Geography

Geography in the coffee industry is more commonly understood in terms of altitude, soil quality or climate zones. However, in the GVC literature, geography takes on a different meaning. Here we mean the geographic proximity of growers to processors and of processors to distributors and retailers. The basic idea is that when stakeholders are located in the same geographic space, there is higher value-added, all things equal. This is because transacting partners share the same pool of workers (who carry knowledge and ideas) and communication is enhanced. Translating the concept of geography to the coffee industry, growers and processors within the same “neighbourhood”, separated by only a short distance, are more likely to exchange ideas and work more closely towards streamlining production (Ellison et al., 2010). The overall effect of geography on value-added is positive, where growers are located closer to processors. We follow the idea of Fernandes et al. (2020) who introduce the average distance to main manufacturing hubs, but align the approach to the coffee industry. In line with the intuition, we include the natural logarithm of the average distance to the capital of Germany, the USA and Italy, which are major hubs for coffee consumption and processed coffee. We expect that with distance to these hubs, GVC integration decreases.

FDI and tariffs (Trade Policy)

Next we turn to the role of foreign direct investment (FDI). In Introduction (Chapter 1), we presented some key statistics from the coffee industry. One problem evident in the statistics is the lack of investment. The problem of oversupply has kept prices at such a low level that many growers find it difficult to cover operating costs and invest in upgrading their technologies and equipment. The result is a shortfall in productivity. This is where we expect FDI to play a compensating role. As such, we would expect the domestic content of exports would rise, with increases in FDI inflows (Stiglitz, 2000; Bickenbach et al., 2018). Stiglitz notes that FDI investment “...brings with it not only resources, but technology, access to markets, and (hopefully) valuable training, an improvement in human capital” (Stiglitz, 2000: 1076).

Accordingly, increased FDI flows to coffee growing countries e.g. Vietnam and Uganda, both of which countries have increased the share of land dedicated to coffee growing of over 30 percent in the period 2000–2018 (Tchibo, 2020), should be associated with a rise in the domestic content of exports (rise in forward integration) or in the amount of green coffee that gets subjected to further processing (roasted or converted into soluble coffee). To measure the effect of FDI inflows, we include the natural logarithm of the latter.

Tariffs are a strongly contested component of any trade talk or study. Yeats (1999) described how basic commodities such as iron-ore mined in Mauritania are typically shipped to industrial nations for further processing. Afterwards, a fraction of the processed product gets re-exported back to Mauritania. The iron-ore example, very much in the mode of traditional trade flows, is somewhat analogous to today’s coffee industry. Low-income coffee growing and industrialised coffee importing countries exhibit a

certain degree of path-dependency, each specializing on its own comparative advantage (coffee growing vs processing).

The reduction or abolition of tariffs (e.g. with the GATT resolutions) would make imports of green coffee cheaper for industrialised countries. According to the traditional idea of comparative advantage, the industrialised countries would then capture the additional value-added from the imported green coffee, converting the raw material into products for the end-customer. The implications would be a reduction in the scope of coffee growing countries to increase their value-added.

Interestingly, although tariff barriers have decreased by about 11 percentage points since the 1960s (Yeats, 1999), the production of low-income and high-income economies is more specialised than would be justified by the small reduction in tariffs. According to Yi (2003), vertical trade accounts for more than 50 percent of the growth in trade. Therefore, regardless of the form it takes (vertical trade or open exchanges), specialisation seems here to stay. Which country will capture the rents from specialised vertical chain of coffee production – a coffee growing country like Uganda, Ethiopia or Vietnam or an importing country like Germany or Italy? This is still an open-ended question. The answer will depend largely on the ownership and activities of multinational firms within the chain of production.

But to return to the question tariffs, what is the prediction for an increase in tariffs on amount of value-added expected for a participant country? We would expect a reduction in tariffs to increase specialisation, lowering the value-added captured by the low- and medium-income coffee producing countries in our analysis. In our empirical investigation, we add the tariff rate on primary goods to capture the effect on GVC integration.

All in all, high tariffs are expected to substantially decrease GVC participation. However, FDI inflows might help to compensate for a shortfall in capital endowments, supporting the emergence of a processing industry.

Industrial Capacity

Next, we capture domestic industrial capacity. Countries with larger domestic industrial capacity have a more established tradition in trade (Fernandes et al., 2020). In the context of the coffee GVC, we expect the domestic industry to drive imports of green coffee for processing and exports of processed coffee. Accordingly, it is also an expected driver of GVC upgrading. We proxy domestic industrial capacity with the natural logarithm of manufacturing value added as percentage of GDP.

Institutional quality

Next, we focus on the institutional quality of a country. Political stability is an important factor for firms to invest in production techniques and to establish an industry in the long run. We capture this importance with the Political Stability Index, one of the many indices provided as part of the Worldwide Governance Indicators by the World Bank (World Bank, 2020b). The index measures the perception of the likelihood of political instability and/or politically motivated violence, including terrorism. A higher value corresponds to higher political stability and we expect a positive boost of political stability on the coffee processing industry.

Macroeconomic factors

Macroeconomic factors shed light on the importance of the overall economic environment. Exchange rates can represent a source of comparative advantage. We capture exchange rate changes using a variable linked to depreciation. The empirical importance of a currency devaluation on GVC integration

is not straightforward. However, in the short run, an unexpected depreciation makes imports costlier and exports cheaper. Since in particular, the world market for green coffee is characterised by a high level of competition, we expect that green coffee exports are most deeply affected by changes in the exchange rate.

Coffee related variables

We go beyond Fernandes et al. (2020) and include additional variables to represent coffee specific factors. We use two dummies to indicate coffee growing countries: first, a dummy if the country is a coffee grower where Arabica dominates; second, a dummy to denote a coffee growing country where Robusta dominates. The intuition is multi-fold. It can be argued that coffee growing countries export higher volumes of green coffee, all things equal, and are less reliant on foreign imports of green coffee. Moreover, coffee growing countries are likely to demonstrate reduced levels of functional upgrading. However, focusing only on coffee growing countries, we expect that Robusta growers might expect to demonstrate higher processing activity because the market for roasted coffee (expected processing path for Arabica coffee) is a notoriously difficult market for developing country processors to enter. End-consumers insist on a high quality of the roasted product. Additionally, the roasted product is highly perishable, difficult/expensive to package and transport without suffering a loss in freshness and quality. This consumer insistence on the highest-quality in a roasted coffee is also in line with increased product upgrading in the cultivation of Arabica vs Robusta. An additional control variable is the natural logarithm of coffee consumption per capita. Intuitively, higher domestic coffee demand leads to higher imports of all forms of coffee. However, a strong domestic demand for coffee might further incentivize domestic production and processing capabilities. Accordingly, we would expect to see a positive effect on exports. Lastly, the question whether domestic consumption influences functional and product upgrading in the same way remains ambiguous. This is because we cannot confirm if cultivation or processing of green coffee gets impacted more strongly.

Supplementary variables

Lastly, we control for some country specific factors. One of these supplementary variables is the natural logarithm of GDP per capita to denote the relative wealth of countries. Smallholder farmers in relatively less-wealthy countries are likely to harvest coffee, but may fail to upgrade their production towards higher quality or processed coffee and accordingly fail to capture any gains in value-added. Moreover, we also use the natural logarithm of a country's population to control for size effects. A larger population might require higher imports and exports. But the scale of trade might just be due to population size, not any differences in demand.

3.4 Results

As described above, we capture three different forms of a country's integration into the coffee GVC - namely exports, imports and GVC upgrading.

Determinants of coffee exports

Table 3 depicts the empirical results on the determinants of a country's coffee exports, including 4-year period fixed-effects. The first column includes the value of all forms of coffee, while each of the columns (2) to (4) focuses on a specific coffee form (green, roasted or soluble).

Table 3: Determinants of countries' exports in coffee

| VARIABLES | (1) Total exports ppml | (2) Exports (green) ppml | (3) Exports (soluble) ppml | (4) Exports (roasted) ppml |
|-----------------------------------|------------------------------|--------------------------------|----------------------------------|----------------------------------|
| (ln) resources rents / GDP | -0.0464*** (0.0104) | -0.0440*** (0.0121) | -0.0450*** (0.0144) | -0.0841*** (0.0267) |
| (ln) capital / GDP | -0.3454* (0.1878) | -0.4192 (0.2632) | 0.5467** (0.2532) | 0.9632* (0.5054) |
| (ln) arable land / GDP | -0.5198*** (0.0565) | -0.6031*** (0.0652) | -0.6034*** (0.0649) | -0.1443* (0.0759) |
| (ln) distance to processing hubs | -4.8772*** (0.5894) | -4.5202*** (0.6808) | -9.1881*** (1.0479) | -7.6992*** (1.3902) |
| (ln) domestic industrial capacity | 0.4975*** (0.1927) | 0.9617*** (0.2174) | 1.0556*** (0.3189) | 0.6770*** (0.2256) |
| Tariffs rate (primary) | -0.0081 (0.0174) | -0.0022 (0.0207) | -0.0248 (0.0218) | -0.1761*** (0.0373) |
| (ln) FDI inflows | 0.1546* (0.0902) | 0.3906*** (0.1401) | 0.2585** (0.1046) | -0.0398 (0.1185) |
| Political stability index | 0.2475* (0.1366) | 0.2089 (0.1412) | -0.0185 (0.1066) | 0.4730** (0.2236) |
| Depreciation | -0.0000 (0.0001) | 0.0003*** (0.0001) | -0.0002 (0.0008) | -0.0012*** (0.0004) |
| (ln) GDP p.c. | -1.2588*** (0.1320) | -1.8736*** (0.1746) | -0.4382** (0.1788) | 0.9323** (0.3714) |
| (ln) population | 0.8368*** (0.1011) | 0.6783*** (0.1489) | 0.9252*** (0.1090) | 1.0672*** (0.0996) |
| (ln) consumption p.c. in kg | 0.8000*** (0.0696) | 0.8231*** (0.0854) | 0.5105*** (0.0977) | 0.5855*** (0.2003) |
| Robusta dominates = 1 | 0.9041*** (0.2185) | 1.6028*** (0.3528) | 1.3738*** (0.3339) | -0.1557 (0.6997) |
| Arabica dominates = 1 | 0.1348 (0.2339) | 1.5453*** (0.3370) | -1.5961*** (0.2960) | -2.0685*** (0.1988) |
| Observations | 780 | 780 | 780 | 780 |
| Period dummy | Yes | Yes | Yes | Yes |
| Pseudo R ² | 0.797 | 0.825 | 0.760 | 0.886 |
| P-value for model test | 0.00 | 0.00 | 0.00 | 0.00 |

Robust standard errors in parentheses

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

Statistically, a high R-squared reveals that our specifications explain much of the between-country variation.

In a nutshell, we see that the direction (coefficient sign) of many of the variables is in line with expectation. Our findings are suggestive of the Dutch Disease problem, where we observe that countries which boast a strong natural resource sector manifest a weaker export performance for all forms of coffee. We should note this problem applies to both processed as well as unprocessed coffee. However, we find in terms of magnitude, the largest negative impact is registered by exports of roasted coffee.

Importantly, capital endowments help to bolster exports of processed coffee. This is consistent with our expectation that it is precisely the processed coffee products which necessitate the highest injection of capital. A large endowment of arable land does not increase exports of any form of coffee. Conversely, we even find a negative effect in all specifications, showing that in particular with low arable land endowment dominate the coffee value chain.

Our findings for geography are in line with our conjecture that geographic proximity to processing and consumption hubs is beneficial for exports of all forms of coffee.

An interesting finding is that domestic industrial capacity positively correlates with all forms of coffee exports. While this result is not surprising for processed coffee, we also find that exports of green coffee are higher in countries with a large industrial capacity.

Trade barriers are seen as harmful to coffee exports, but only significant in the case of roasted coffee exports. FDI inflows positively correlate with exports of green and soluble coffee, respectively. However, this measure lacks granularity and we cannot track the sector of FDI inflows.

Countries with a higher political stability export significantly more roasted coffee. This might link with the high investment needed to set-up an industry specialising in roasted coffee, a finding in line with our prior results on domestic industrial capacity and capital endowments.

A currency depreciation boosts, as expected, a country's competitiveness in the green coffee markets (traded on the New York and London commodity markets). However, we can even reveal a negative effect on roasted coffee exports and no effect on exports of soluble coffee.

Our coffee related variables demonstrate that domestic consumption links to increased exports of all coffee varieties. This indicates that a domestic preference for coffee appears to build a base for supporting a thriving domestic coffee industry. In line with intuition, both Robusta and Arabica production increases the exports of green coffee. If Robusta dominates the coffee production, a country is also more likely to commence exporting soluble coffee. Since Robusta is the main input for soluble coffee, this result is hardly surprising. However, it illustrates that domestic Robusta cultivation is already used as an input for processed coffee. A similar pattern is not observable for roasted coffee, where the market entrance barriers are much higher. Interestingly, cultivation of Arabica coffee even decreases the volume of roasted coffee exported, showing that the roasted coffee sector is dominated by non-coffee growing countries.

The findings for wealth (per capita GDP) make for somewhat depressing news. The lowest income countries appear to be more locked-in to green coffee exports. A possible explanation is that poorer countries suffer from relatively undiversified economies. This shapes their higher dependence on exports of a few core commodities such as cocoa, palm oil or coffee. As such, they are more likely to be locked-in to exports of these commodities with little opportunity to shift production to an alternative sector or industry. Soluble coffee is also more likely to be exported by less wealthy countries, but since there is already some value creation embodied in soluble coffee, this might serve as a step in the direction for increased value creation within these countries. Roasted coffee is predominantly exported by industrialised countries.

Finally, we note that population serves as a control for country scale effects and is positively significant in all specifications.

Determinants of coffee imports

Next, we shift the focus to coffee imports. Results are presented in Table 4.

We first turn to the wealth indicator (per capita GDP). Wealthy countries are more likely to import all forms of coffee. A higher amount of green coffee imports suggests backward GVC integration, where coffee inputs are sourced by participants in the coffee importing country, processed and subsequently sold to the end-customer. The overall finding suggests that wealthy countries, on average, cater to the demand from their consumers for highly differentiated, highly branded, quality end-products. For this reason, such countries opt to conduct the lion's share of the coffee processing themselves. There is little scope for coffee growing countries to conduct their own processing. In line with this finding, countries with higher per capita coffee consumption show higher imports of all kind of coffee products. Coffee growing countries themselves show reduced imports. Interestingly, this is not the case for green beans in countries where Robusta dominates. We will refer to this finding later when analysing the drivers of functional upgrading to reveal whether these countries are more likely to build up an industry for soluble coffee based on domestic production and imports of Robusta beans.

Capital is found to be beneficial to imports of processed coffee, but not green coffee. This finding seems somewhat counter-intuitive, since it would be expected that imports of green coffee would benefit most from capital deepening. However, we cannot say conclusively from our examination of coffee imports that imports of soluble or roasted coffee are directly consumed or alternatively, further processed, e.g. packaging or labelling, before being re-exported. The latter scenario is somewhat consistent with our earlier finding that exports of processed coffee are seen to increase with capital endowment.

Our geography variable reveals an interesting finding. Distance to processing hubs is harmful for imports of green and roasted coffee, but beneficial for soluble coffee. For this reason, coffee growing countries which are located at a remove from processing hubs are less likely to be backward integrated within the coffee GVC. However, the soluble coffee value chain shows another geographic centre indicated by a positive correlation. In words, if a country is closer to the manufacturing centres of soluble coffee, the import magnitude decreases. A reason for this might be the preference towards consumption of soluble coffee in many Asian countries.

Consistent with our earlier finding for wealth, countries with a strong industrial capacity seem to favour imports of green vs processed coffee. This would suggest that they have the capability to process the coffee for later exports or in such a way as to satisfy the domestic demands of their highly sophisticated consumers.

Tariffs adversely affect imports of processed coffee. This might have to do with the progressive nature of tariffs – differentiating between products which are primary (cultivation of coffee) or that embody some element of value added (processed coffee). We conclude that tariffs discourage developing countries from adding value to their coffee exports.

Depreciation of the domestic currency has no effect on imports of green and soluble coffee, but increases the level of roasted coffee imports.

On a positive note, FDI correlates with imports of all three coffee forms. This may be suggestive of vertical integration and in line with Alfaro and Charlton (2009) which demonstrates that much FDI takes the form of vertical integration and multinational enterprises from industrialised countries source commodities from developing countries via vertical relationships. This also provides initial evidence of backward integration.

Political stability only positively correlates with imports of roasted coffee, reflecting perhaps the consumption of roasted coffee in many highly industrialised countries – which also show a higher score in the political stability index.

Table 4: Determinants of countries' imports in coffee

| VARIABLES | (1) Total imports ppml | (2) Imports (green) ppml | (3) Imports (soluble) ppml | (4) Imports (roast ppml |
|-----------------------------------|------------------------------|--------------------------------|----------------------------------|-------------------------------|
| (ln) resources rents / GDP | -0.0129*** (0.0035) | -0.0046 (0.0050) | -0.0049 (0.0058) | -0.0546*** (0.0081) |
| (ln) capital / GDP | 0.3627*** (0.1141) | 0.0411 (0.1643) | 0.4860** (0.1959) | 0.9831*** (0.1841) |
| (ln) arable land / GDP | 0.0752** (0.0303) | -0.0080 (0.0373) | 0.1463*** (0.0444) | 0.1868*** (0.0408) |
| (ln) distance to processing hubs | -0.8658*** (0.2768) | -1.5192*** (0.3814) | 1.0384** (0.4358) | -1.8281*** (0.4410) |
| (ln) domestic industrial capacity | 0.4378*** (0.1010) | 0.9119*** (0.1390) | 0.0630 (0.1189) | -0.1962 (0.1392) |
| Tariffs rate (primary) | -0.0366*** (0.0077) | -0.0145 (0.0090) | -0.0466*** (0.0161) | -0.0783*** (0.0165) |
| (ln) FDI inflows | 0.1090*** (0.0342) | 0.0826** (0.0404) | 0.2302*** (0.0560) | 0.2445*** (0.0620) |
| Political stability index | 0.1178** (0.0594) | 0.0133 (0.0754) | 0.0065 (0.0855) | 0.2575** (0.1065) |
| Depreciation | 0.0006** (0.0003) | 0.0000 (0.0002) | 0.0017 (0.0015) | 0.0026*** (0.0004) |
| (ln) GDP p.c. | 0.8672*** (0.1518) | 1.0098*** (0.1941) | 0.4162*** (0.1402) | 0.9339*** (0.1739) |
| (ln) population | 0.8233*** (0.0355) | 0.9513*** (0.0418) | 0.5691*** (0.0505) | 0.5969*** (0.0610) |
| (ln) consumption p.c. in kg | 0.4114*** (0.0699) | 0.5466*** (0.0922) | 0.2852*** (0.0514) | 0.2785*** (0.0903) |
| Robusta dominates = 1 | -0.5524** (0.2363) | 0.1323 (0.2837) | -1.2239*** (0.2570) | -1.5385*** (0.3281) |
| Arabica dominates = 1 | -0.8342*** (0.1042) | -0.6712*** (0.1206) | -1.1525*** (0.1710) | -1.7524*** (0.1473) |
| Observations | 780 | 780 | 780 | 780 |
| Period dummy | Yes | Yes | Yes | Yes |
| Pseudo R ² | 0.943 | 0.934 | 0.768 | 0.893 |
| P-value for model test | 0.00 | 0.00 | 0.00 | 0.00 |

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

Determinants of functional upgrading and product upgrading

Next, we turn to the determinants of a country's functional upgrading and product upgrading.

Columns (1) and (2) of Table 5 depict the results of the determinants of functional upgrading. This time the emphasis is on the portion of processed coffees embodied in total coffee exports. A higher value is associated with an increased share of processed exports relative to green coffee. While the first column includes all countries, the second column focuses only on coffee growing countries. In a third specification, we focus on product upgrading within green coffee production. Again, the analysis focuses on coffee growing countries. Product upgrading is measured by the export revenue in constant USD per unit of green coffee exported. As in Section 2.2 and Section 2.4, we argue that a higher unit price indicates a higher quality of the green coffee, e.g. Arabica vs Robusta. Alternatively, a higher price is suggestive of selective hand-picking or washed Arabica coffee cherries.

Browsing the results, we note the same negative pattern for natural resources on functional and product upgrading. This is in line with our findings on the determinants of exports. As already argued, the presence of competition from natural resources e.g. petroleum, appears to crowd out quality improvements in the coffee industry. We have already alluded to the Dutch Disease in this context. However, we can state that this is explicitly harmful vs the upgrading of the industry towards products with increased value-added.

Moreover, higher levels of capitalisation are consistent with higher evidence of processing and product upgrading. Low- and medium income coffee producers require a minimum level of capitalisation in order to carry out any processing or product upgrading, adding to the value of the raw commodity.

Industrial capacity is also strongly predictive of functional upgrading. However, industrial capacity does not determine improvements in the unit price of green coffee. This opens the box for countries with a weak industry base to increase revenues with the introduction of product upgrading, which is less reliant on industrial capacity.

Consistent with our results so far, tariffs are catastrophic for countries seeking to add value to their exports by functional upgrading. In words, tariffs in particular hamper countries in stepping-up their processed coffee exports. FDI inflows seem not to be a major driver of both product upgrading and the upgrading towards coffee processing. However, we find some positive effects on exports for green and soluble coffee, as discussed before. Accordingly, we conclude from the column (2) that FDI inflows in coffee growing countries is more important for exports of green coffee vs processed coffee, but still acknowledging the missed opportunity to control for coffee sector related FDI inflows.

Political instability appears to reduce the ability of countries to functional upgrade, but has no significant effect on product upgrading. A depreciation in the national currency of the coffee exporter favours the exporting of green vs processed coffees. Moreover, a depreciation supports product upgrading by making exports of green coffee relatively more competitive on the world market.

One clear cut finding is the strong result for wealth – higher wealth is strongly associated with the production of increased volumes of processed coffee outputs. We should highlight that the magnitude of this coefficient is sizeable. Interestingly, and in line to our findings on industrial capacity, GDP p.c. is not an important determinant of product upgrading. The missing correlation of GDP p.c. and product upgrading indicates that also relatively poorer countries can enter green coffee markets with a higher price per unit.

Finally, countries characterised by high coffee consumption are neither more likely to show higher functional or product improvements in green coffee. This finding remains in contrast with our expectation that a larger domestic market incentivises countries to domestically process their coffee. Coffee growing countries are more likely to export green vs. processed coffees. However, the column (2) shows that this is in particular the case for Arabica producing countries, revealed by the higher functional upgrading activity of Robusta growing countries vs. Arabica growing countries. This is in line with a more stringent entry barrier encountered by firms aiming to export roasted- vs. soluble coffee, where Robusta serves as the main input. In line with the prior finding that Robusta production does not necessarily decrease imports of Robusta green beans, we argue that this is suggestive of functional upgrading towards soluble coffee, using domestic and imported Robusta beans. From the column (3) we can note that Arabica is traded at significant higher prices compared to Robusta. All in all, these findings echo our findings in Section 2.2-2.4.

Somewhat surprisingly, higher arable land-to-GDP ratios are associated with higher evidence of upgrading, but the effect is not observable for coffee growing countries and even turns negative for product upgrading. The latter finding suggests the opportunity for small countries to specialise in a higher product quality when exporting green coffee. Lastly, we find that missing geographic proximity does indeed hinder functional upgrading for coffee producing countries, but it has no effect on the product upgrading in green coffee.

Table 5: Determinants of countries' GVC upgrading

| VARIABLES | (1) | (2) | (3) |
|-----------------------------------|---------------------------------|---------------------------------|--------------------------------|
| | Functional upgr. all ppml | Functional upgr. all ppml | Product upgr. green ppml |
| (ln) resources rents / GDP | -0.0108*** (0.0022) | -0.0504*** (0.0161) | -0.0415*** (0.0064) |
| (ln) capital / GDP | 0.1747*** (0.0449) | 0.6398** (0.2950) | 0.4968*** (0.1035) |
| (ln) arable land / GDP | 0.0336** (0.0131) | -0.0984 (0.1051) | -0.4171*** (0.0738) |
| (ln) distance to processing hubs | 0.0784 (0.1857) | -1.9756** (0.9495) | 0.4326 (0.3344) |
| (ln) domestic industrial capacity | 0.1722*** (0.0399) | 0.8894*** (0.3218) | -0.5773*** (0.1096) |
| Tariffs rate (primary) | -0.0105** (0.0047) | -0.0737*** (0.0218) | 0.0062 (0.0102) |
| (ln) FDI inflows | 0.0122 (0.0196) | -0.4653*** (0.1199) | 0.0087 (0.0495) |
| Political stability index | -0.0947*** (0.0293) | -0.2682* (0.1448) | -0.1086 (0.0771) |
| Depreciation | -0.0004*** (0.0001) | -0.0005*** (0.0001) | 0.0002*** (0.0001) |
| (ln) GDP p.c. | 0.2136*** (0.0432) | 1.3130*** (0.1658) | -0.1600 (0.1117) |
| (ln) population | -0.0058 (0.0185) | 0.4598*** (0.1296) | -0.1468** (0.0659) |
| (ln) consumption p.c. in kg | -0.0314 (0.0197) | -0.1910** (0.0767) | -0.0826*** (0.0251) |
| Robusta dominates = 1 | -1.0747*** (0.1394) | 1.2283*** (0.2758) | -0.5459*** (0.1022) |
| Arabica dominates = 1 | -1.5992*** (0.1443) | | |
| Observations | 737 | 244 | 250 |
| Period dummy | Yes | Yes | Yes |
| Pseudo R ² | 0.128 | 0.263 | 0.640 |
| P-value for model test | 0.00 | 0.00 | 0.00 |
| Sample | | Only coffee growing | Only coffee growing |

Robust standard errors in parentheses

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

We can summarise the key findings of our regression analysis as follows. The predominantly low- and medium-income coffee growing countries require some minimum level of capital and industrial capability before they can add value to their exports. In other words, exports of processed coffee, including roasted and soluble coffee, are impacted by capital endowments and access to a domestic (or otherwise) manufacturing base.

Poorer coffee producing countries have little choice but to continue exporting unprocessed, green coffee. However, conversely to functional upgrading, a strong manufacturing base is not a significant driver of product upgrading. Accordingly, this opens possibilities for less-wealthier countries to specialise in product upgrading.

Moreover, coffee growing countries equipped with a relatively stronger manufacturing base and capital endowment might be positioned to functionally upgrade, producing soluble coffee based on domestically cultivated and imported Robusta, respectively.

An interesting finding is the consensus that tariffs are catastrophic for functional upgrading, seeking to capture higher value added. Tariffs seem to consign such countries to a 'raw commodity only' economic trajectory.

Another unambiguous finding, repeated across several of our regressions, is the role of wealth in richer, non-coffee growing countries. Such economies, endowed with capital and consumer wealth, appear to cater to the needs of their sophisticated base, preferring to import green coffee and conduct the value-

added themselves. Part of this pattern may be demand driven. Perhaps, poorer coffee producing countries lack the capabilities (low capital endowment and manufacturing base) and expertise to manufacture the high-end product necessitated by the world's wealthiest economies, e.g. to maintain a consistent quality level, green coffee can be sourced from different regions and at different harvest times.

We have evidence that stakeholders in the coffee industry must compete vigorously for resources within their own countries. Our findings suggest that the coffee industry in certain coffee producing countries endowed with higher levels of natural resources faces the Dutch Disease and must compete with other sectors for labour and capital, bidding the prices up. This finding is valid for functional and product upgrading. This finding is quite plausible given the undisputed position enjoyed by natural resources such as mining and extractive industries (raw resources). Coffee growers from these countries face a disadvantage when trying to step up the quality ladder.

A final, somewhat worrying result is the partly weak performance of FDI in supporting the coffee processing sector within the coffee growing economies. FDI inflows positively correlate to exports of green and soluble coffee. But our analysis on functional upgrading shows it rather shifts higher volumes of green coffee exports compared to processed coffee exports. This form of vertical FDI is very much in line with the evidence by Alfaro and Charlton (2009) that much of the North-South FDI follows the traditional fault lines – the South produces and the North processes. However, we should note that we do not capture FDI inflows directed to the coffee industry and rather countries' overall FDI inflows.

4 Policy implications

This study has taken a GVC perspective on the international coffee industry. The proliferation of GVCs is widely recognized as a major driver of economic growth and poverty reduction as it enables producers around the world to participate in and source from global markets (see e.g. IBRD & World Bank, 2020). Therefore, GVCs are also regarded as a means to achieve the UN Sustainable Development Goals. Production in GVCs is characterised by specialisation and longer-term firm-to-firm relationships along the value chain. Specialisation has the potential to improve productivity of firms even when they have limited capital and skill and can only serve a specific activity in the value chain. Longer-term relationships can eliminate excessive fluctuations in demand and supply, both of which can enhance and stabilise income flows for all parties along the chain. They also potentially increase knowledge transfer and quality upgrading (e.g. Görg et al., 2018). In an agro-food industry such as the coffee industry, GVCs allow to link smallholder farmers in developing countries to consumers worldwide.

In general, GVC integration is driven by country-level endowments (labour, capital, land), market size, geographical conditions (distance to markets, climate, topography), and institutions (political stability, trust) (see, e.g., IBRD & World Bank, 2020). All these determinants can, in principle, be improved through economic policies, allowing countries to participate in GVCs and to upgrade within the GVCs. Upgrading within the GVCs has been shown to deliver large economic gains in terms of growth and jobs, especially an upgrading from exporting commodities to exporting processed products. Due to this large potential, policy makers should consider and understand how GVCs work and how its benefits can be reaped. While there are some general prescriptions for increasing GVC participation, industry and country circumstances matter, too.

A general obstacle to GVC proliferation across the world is increasing protectionism. In GVCs, goods and services cross borders several times during the production process. Tariffs will therefore accrue several times and add up with an increasing number of production steps. Delivery times are also important as the high degree of specialisation in GVCs requires a frictionless interaction between the suppliers. Tariffs and especially non-tariff trade barriers slow down this interaction. Hence, for reaping the full potential of GVCs, the world community must continue to pursue low trade barriers and negotiate trade agreements. With a liberal trade regime and good transportation and communications infrastructure, even small countries in remote locations can become beneficiaries of global markets.

It is important to note that it is not countries that trade, but firms. While the government can set the scene with a range of beneficial policies, firms have a role to play in making GVCs work and in taking care of sustainable development along the chain. Especially in the agriculture and food sector, including coffee, there are large multinational players with significant market power. These players must understand their immense responsibility in promoting sustainable development, protecting the environment, and sustaining incomes in their supplier countries. With a well-managed supply chain and complementary government policies, both smallholder farmers in coffee growing countries and firms engaged worldwide stand to gain from GVC integration.

The GVC in the coffee sector is characterised by a relatively simple value chain: it begins upstream with raw materials (green coffee), which can only be produced in specific climatic and geographic conditions. Coffee crops are cultivated, harvested and undergo post-harvest processing and then are mostly exported as green coffee. Most countries growing coffee are developing or emerging countries. Green coffee comes in two varieties, Robusta or Arabica. Robusta coffee is of lower quality than Arabica and sells at a lower unit price, but it can be grown in lower altitudes and harvesting and post-harvest processing is less costly. Green coffee is differentiated by the taste profile, the method of harvesting and post-harvest processing at washing stations and mills. Green coffee is subsequently processed into soluble coffee (mainly Robusta) or roasted coffee (mainly Arabica). Soluble coffee can be easily stored and transported, while roasted coffee is highly perishable and should not be transported over long distances, given the current packaging technologies.

Our analysis in Section 2.2 shows that roasted coffee exports have developed most favourably throughout the study period. A strongly positive price development coupled with increasing export volumes has greatly increased the revenues for roasted coffee producers. Similarly, export volumes of soluble coffee have increased strongly, albeit at a decreasing unit price. In contrast, export volumes of green coffee from Arabica growers have increased only little and unit prices only increased very little. While export volumes of Robusta green coffee increased somewhat more, the unit price has increased very little, too. Over the last three decades, roasted coffee producers are clearly the winners in terms of revenues.

Hence, it would in principle be advantageous for coffee growing countries to capture more downstream sections of the value chain because the development in green coffee exports is less favourable than in processed coffee. Generally, “trade in unprocessed agricultural goods and commodities has no systematic and statistically significant relationship with growth in per capita GDP.” (IBRD & World Bank, 2020: 73). In other words, a specialisation in agricultural production does not make a country richer. Yet, we know that particularly the transition from commodities to limited manufacturing triggers strong economic growth. For the coffee sector this means that countries should try to leverage GVCs to move into producing soluble or roasted coffee.

What are the options of the coffee growing countries for functional upgrading in the value chain? For Robusta-growing countries, there is the option of forward integration: countries could aim at processing Robusta beans into soluble coffee and thereby capturing more of the higher value-added downstream activities of the coffee GVC. We address this further down. For Arabica-growing countries, the options are limited. There are several reasons that bar Arabica-growing countries from entering the downstream activities of the value chain: (1) the high perishability of roasted coffee and thus the limited possibilities to transport over long distances, (2) strong national brands in rich consuming countries paired with limited demand in the growing countries' domestic economies, (3) tariff escalation in the industry, i.e. higher tariffs on processed coffee, and (4) an increasing concentration of roasted coffee exports (see Section 2.4), making it harder for new entrants to compete. Against this background, significant income gains for Arabica-growing countries can only come from product upgrading, i.e. improving the quality of the Arabica coffee beans through, for example, more sophisticated and advanced cultivation methods, harvesting technology and post-harvest processing. This means that there is a rather severe impediment for these countries to engage in downstream activities through functional upgrading along the coffee GVC, which is highly unfortunate because roasted coffee has seen the biggest increases in exports, as shown above.

The regressions on roasted coffee exports in Chapter 3 also suggest the lock-in of poor countries into the export of green coffee. In Table 3, the indicator for wealth (GDP per capita) is strongly positive, validating that this activity is done by richer countries. Similarly, capital endowment and the overall industrial capacity, which are both low in developing countries, are positively associated with roasted coffee exports. FDI inflows are not significantly related to roasted coffee exports, so they are no remedy either. The findings from the regressions on functional upgrading (Table 5) are similarly discouraging. *Ceteris paribus*, wealthier and capital-rich countries have a higher share of processed coffee in exports. Yet, the regression on product upgrading in Table 5 shows that this route can be taken by poorer countries because wealth and industrial capacity are unrelated to product upgrading.

Looking at the industry in the aggregate, Section 2.1 shows that coffee exports have increased substantially between the early 1990s and 2018. There is also evidence that today more countries trade coffee products (in all three coffee forms considered) than in the 1990s, in particular soluble coffee, as can be observed from the falling extensive margin of concentration across countries over time (Section 2.4.1). Despite the integration of more countries in the coffee GVC, the overall concentration of the roasted coffee exports increased strongly, particularly since the early 2000s. Here the increasing concentration within regions played an important role.

One country stands out as a driver of the increasing concentration in the roasted coffee trade: Switzerland. The green coffee, which is then processed and on which the market expansion is based, is entirely imported. This gives Swiss companies a particular responsibility in ensuring sustainable development in their partner countries. Experiences in Rwanda indicate how this could work: coffee exporters in Rwanda are typically subsidiaries of multinationals (Blouin et al., 2018). In public-private partnerships, interventions for better technology and skills were set up that allowed farmers to produce higher-quality, fully-washed coffee selling at a higher price (Karuretwa, 2016). Multinational firms

shared the responsibility with government to contribute to a positive development and could eventually benefit from better-quality coffee.¹³

Such longer-term firm-to-firm relationships can bring a number of additional benefits. Beyond more stable incomes and improvements in quality because of loans and training, GVC lead firms can also contribute to better working conditions and the formalization of employment, which typically also involves higher wages. They can also help farmers with production inputs technology or market information, and provide tools for risk management. After all, GVC relationships should be understood as “networks of firms with common goals”, where an improvement of one partner is beneficial for the other (IBRD & World Bank, 2020: 70). With responsible governance of GVCs, lead firms would make a clear contribution to the achievement of the Sustainable Development Goals. In any case, complementary government policy has to support firms’ activities. This involves, for example, the structure of industrial organization, e.g., if coffee is sold on auction markets (making it difficult for lead firms to integrate) or if coffee can be diversified.

Coming back to Robusta coffee and the associated downstream product, soluble coffee, the findings look more promising with respect to functional upgrading along the coffee GVC. From the regression on soluble coffee exports (Table 3), we find that wealth is no longer a determining factor, but that soluble coffee is rather exported by poorer countries. Capital endowment is relevant, FDI inflows are supportive, and – importantly – a higher domestic industrial capacity is positively related to soluble exports. Notably, there is also evidence for a Dutch Disease effect at work, which is known for driving up labour costs and tying in resources. The regressions for functional upgrading (Table 5) strengthen these results and also show the significantly negative impact of trade barriers.

For Robusta-growing countries, we can thus observe a classic example for the potential of functional upgrading, in which countries move from exporting commodities to exporting simple manufacturing goods. In order to tap the potential, countries growing Robusta coffee crops can use standard instruments to achieve GVC upgrading: introduce policies to attract FDI, increase the capital base by eliminating barriers to investment, diversify away from resource sectors to ensure competitively priced labour, or improve institutional quality. Moreover, as mentioned above, low trade barriers are essential for tapping the development potential of GVCs, as also found in the regression results. The trade liberalisation agenda has to stay firmly on the agenda of multilateral forums.

A country, which has substantially increased its market share in soluble coffee is Vietnam. The Vietnamese government has generally pursued a strategy for increasing GVC participation (see e.g. IBRD & World Bank, 2020: 175), and this has also benefitted the coffee industry: soluble coffee exports have strongly increased (and have likely driven down the prices), and the same holds for green coffee exports. In addition, Vietnam has apparently benefitted from its proximity to consumers in Asia as it now also exports more roasted coffee at a higher price than the early 1990s. The case of Vietnam highlights another important determinant of successful GVC integration: connectivity. A good transportation infrastructure, the possibility for international logistics firms to operate in the country, and a quick

¹³ Another interesting country is Colombia. Colombia succeeded in selling more roasted coffee at higher prices globally over time. Its success increased the concentration of the roasted coffee exports within South America (s. Section 2.4.1). Despite its success, Colombia still accounted for only a small share of roasted coffee exports worldwide. Colombia is one of the cases where local engagement through, for example, the Colombian Coffee Federation and support from international organisations seemed to have helped to overcome the barriers to roasted coffee processing (CBI, 2015; WIPO, 2012).

handling at ports and borders allows countries to be better connected to global markets thus to benefit more from GVC integration.

This study was based on aggregate, country-level, data for coffee exports and imports, even though differentiated by coffee form, and on country-level data from third-party sources that are generally not specific to the coffee sector. Yet, for analysing the determinants of GVC integration and particularly for the evaluation of successful policies, it would be helpful to have data at a much more granular level. For example, it would be helpful to know more about employment and wages in the coffee sector, or about industry-specific FDI flows. Collecting more granular data will not only help researchers to better study GVC integration in the coffee sector. It will also help firms and governments to better understand the impact of their policies and initiatives and could thereby significantly support sustainable development.

Unlike many other agricultural markets, coffee is not grown primarily for domestic consumption but is largely exported. It has always been like that. In that sense, coffee growers have always been part of the coffee GVC without reaping significant benefits from it. Yet, understanding the difference between simple trade and integration in the coffee GVC (with specialisation and longer-term firm-to-firm relationships) and the possible benefits from it, must remain firmly fixed in the policy-maker's mind. Only then is it possible to achieve progress, by devising targeted policies to increase GVC participation and connecting smallholder farmers to lead firms in the industry.

5 Conclusions

This study looked at the coffee industry through a "GVC lens", seeking evidence for how GVCs support sustainable development, particularly in developing countries, and making recommendations on how to improve GVC integration. The coffee GVC follows a relatively simple structure, with mainly developing (and emerging) countries growing and harvesting coffee, which is then mostly exported and processed into soluble and roasted coffee. Robusta beans are primarily processed into soluble coffee; Arabica beans are primarily processed into roasted coffee. Most coffee consumers are located in richer countries. The biggest gains in terms of export volume and export price were achieved for roasted coffee, while the success of green coffee producers in improving their export outcomes was rather limited over the last three decades.

Taking a GVC perspective, we note that there is currently a strong disconnect between coffee growers and consumers. Coffee is often auctioned on global markets and, hence, it is generally difficult to establish and maintain any direct and close relationship between downstream firms and upstream farmers. Most of the innovation, quality improvement and technological advances seem to happen in the roasted coffee sector. Yet, we could detect some progress also in the green coffee sector, where some countries were able to achieve higher prices for their coffee, albeit often at the cost of decreasing export volumes.

There are strong limitations for Arabica producers to capture downstream sections of the value chain and go into roasted coffee exports. They are usually left with the option of improving the quality of their coffee beans in order to achieve higher market prices. Here, we consider backward integration by multinational lead firms, supported by complementary policy initiatives from local governments, to be a way forward. In public-private partnerships, the downstream firms could provide finance and insurance, support skill development and employment formalisation, and provide technical and managerial know-how. Given the importance of the coffee sector in some developing countries, such

initiatives would be a major contribution to achieving the Sustainable Development Goals. Downstream firms would reliably secure higher-quality coffee.

For Robusta producers, we find that the route to capturing downstream sections of the value chain is viable, as coffee growing countries are increasingly producing soluble coffee. Standard instruments for improving participation and upgrading in GVCs can be used by governments in order to secure a successful market entry and development.

Our analysis of the coffee sector once again showed that business and development must be considered together and a “GVC mindset” helps to do this. Through specialisation and longer-term relationship, companies can become more efficient and product quality can be significantly improved. The international community has to make sure that increasing protectionism does not interrupt GVCs, but that trade is kept open so as this route to development for developing, particularly coffee growing, countries is not blocked.

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APPENDIX

Table A1: country list for the analysis in Chapter 2

| Country | Region | Full | Subset | Country | Region | Full | Subset |
|---------------------------------------|--------|------|--------|----------------------------------|--------|------|--------|
| Afghanistan | AS | x | x | Lesotho | AF | x | x |
| Albania | EP | x | x | Liberia | AF | x | x |
| Algeria | ME | x | x | Libya | ME | x | x |
| American Samoa | OC | x | x | Liechtenstein | EP | x | x |
| Andorra | EP | x | x | Lithuania | EU | x | x |
| Angola | AF | x | x | Madagascar | AF | x | x |
| Anguilla | CA | x | | Malawi | AF | x | x |
| Antigua and Barbuda | CA | x | x | Malaysia | AS | x | x |
| Argentina | SA | x | x | Maldives | AS | x | x |
| Armenia | AS | x | x | Mali | AF | x | x |
| Aruba | CA | x | x | Malta | EU | x | x |
| Australia | OC | x | x | Marshall Islands | OC | x | x |
| Austria | EU | x | x | Martinique | CA | x | |
| Azerbaijan | AS | x | x | Mauritania | ME | x | x |
| Azores and Madeira | EU | x | | Mauritius | AF | x | x |
| Bahamas | CA | x | x | Mayotte | AF | x | |
| Bahrain | ME | x | x | Melilla | EP | x | |
| Bangladesh | AS | x | x | Mexico | CA | x | x |
| Barbados | CA | x | x | Micronesia (Federated States of) | OC | x | x |
| Belarus | EP | x | x | Monaco | EP | x | x |
| Belgium and Luxembourg | EU | x | x | Mongolia | AS | x | x |
| Belize | CA | x | x | Montenegro | EP | x | x |
| Benin | AF | x | x | Montserrat | CA | x | |
| Bermuda | NA | x | x | Morocco | ME | x | x |
| Bhutan | AS | x | x | Mozambique | AF | x | x |
| Bolivia (Plurinational State of) | SA | x | x | Myanmar | AS | x | x |
| Bonaire, Sint Eustatius and Saba | CA | x | | Namibia | AF | x | x |
| Bosnia and Herzegovina | EP | x | x | Nauru | OC | x | x |
| Botswana | AF | x | x | Nepal | AS | x | x |
| Brazil | SA | x | x | Netherlands | EU | x | x |
| British Virgin Islands | CA | x | x | Netherlands Antilles (former) | CA | x | |
| Brunei Darussalam | AS | x | x | New Caledonia | OC | x | x |
| Bulgaria | EU | x | x | New Zealand | OC | x | x |
| Burkina Faso | AF | x | x | Nicaragua | CA | x | x |
| Burundi | AF | x | x | Niger | AF | x | x |
| Cabo Verde | AF | x | x | Nigeria | AF | x | x |
| Cambodia | AS | x | x | Niue | OC | x | |
| Cameroon | AF | x | x | Norfolk Island | OC | x | |
| Canada | NA | x | x | North Macedonia | EP | x | x |
| Caroline Islands | OC | x | | Northern Mariana Islands | OC | x | x |
| Cayman Islands | CA | x | x | Norway | EP | x | x |
| Central African Republic | AF | x | x | Oman | ME | x | x |
| Ceuta | EU | x | | Pakistan | AS | x | x |
| Chad | AF | x | x | Palau | OC | x | x |
| Chile | SA | x | x | Panama | CA | x | x |
| China (mainland, HK and MK) | AS | x | x | Papua New Guinea | OC | x | x |
| Christmas Islands | OC | x | | Paraguay | SA | x | x |
| Cocos (Keeling) Islands | OC | x | | Peru | SA | x | x |
| Colombia | SA | x | x | Philippines | AS | x | x |
| Comoros | ME | x | x | Pitcairn | OC | x | |
| Congo | AF | x | x | Poland | EU | x | x |
| Cook Islands | AS | x | | Portugal | EU | x | x |
| Costa Rica | CA | x | x | Puerto Rico | CA | x | x |
| Côte d'Ivoire | AF | x | x | Qatar | ME | x | x |
| Croatia | EU | x | x | Republic of Korea | AS | x | x |
| Cuba | CA | x | x | Republic of Moldova | EP | x | x |
| Curaçao | CA | x | x | Réunion | AF | x | |
| Cyprus | EU | x | x | Romania | EU | x | x |
| Czech Republic | EU | x | x | Russian Federation | EP | x | x |
| Democratic People's Republic of Korea | AS | x | x | Rwanda | AF | x | x |
| Democratic Republic of Congo | AF | x | x | Saint Helena | AF | x | |
| Denmark | EU | x | x | Saint Kitts and Nevis | CA | x | x |

| | | | | | | | |
|----------------------------------|----|---|---|--------------------------------|----|---|---|
| Djibouti | ME | x | x | Saint Lucia | CA | x | x |
| Dominica | CA | x | x | Saint Pierre and Miquelon | NA | x | |
| Dominican Republic | CA | x | x | Saint Vincent & the Grenadines | CA | x | x |
| Ecuador | SA | x | x | Samoa | OC | x | x |
| Egypt | ME | x | x | San Marino | EP | x | x |
| El Salvador | CA | x | x | Sao Tome and Principe | AF | x | x |
| Equatorial Guinea | AF | x | x | Saudi Arabia | ME | x | x |
| Eritrea | AF | x | | Senegal | AF | x | x |
| Estonia | EU | x | x | Serbia | EP | x | x |
| Eswatini | AF | x | x | Seychelles | AF | x | x |
| Ethiopia | AF | x | x | Sierra Leone | AF | x | x |
| Falkland Islands (Malvinas) | SA | x | | Singapore | AS | x | x |
| Faroe Islands | EU | x | x | Slovakia | EU | x | x |
| Fiji | OC | x | x | Slovenia | EU | x | x |
| Finland | EU | x | x | Solomon Islands | OC | x | x |
| France | EU | x | x | Somalia | ME | x | x |
| French Guiana | SA | x | | South Africa | AF | x | x |
| French Polynesia | OC | x | x | South Sudan | AF | x | x |
| Gabon | AF | x | x | Spain | EU | x | x |
| Gambia | AF | x | x | Sri Lanka | AS | x | x |
| Georgia | AS | x | x | State of Palestine | ME | x | x |
| Germany | EU | x | x | Sudan | ME | x | x |
| Ghana | AF | x | x | Suriname | SA | x | x |
| Gibraltar | EP | x | x | Svalbard and Jan Mayen Islands | EP | x | |
| Greece | EU | x | x | Sweden | EU | x | x |
| Greenland | NA | x | x | Switzerland | EP | x | x |
| Grenada | CA | x | x | Syrian Arab Republic | ME | x | x |
| Guadeloupe | CA | x | | Tahiti | OC | x | |
| Guam | OC | x | x | Taiwan | AS | x | |
| Guatemala | CA | x | x | Tajikistan | AS | x | x |
| Guinea | AF | x | x | Tanzania | AF | x | x |
| Guinea-Bissau | AF | x | x | Thailand | AS | x | x |
| Guyana | SA | x | x | Timor-Leste | AS | x | x |
| Haiti | CA | x | x | Togo | AF | x | x |
| Holy See | EP | x | | Tokelau | OC | x | |
| Honduras | CA | x | x | Tonga | OC | x | x |
| Hungary | EU | x | x | Trinidad & Tobago | CA | x | x |
| Iceland | EP | x | x | Tunisia | ME | x | x |
| India | AS | x | x | Turkey | AS | x | x |
| Indonesia | AS | x | x | Turkmenistan | AS | x | x |
| Iran (Islamic Republic of) | ME | x | x | Turks & Caicos Islands | CA | x | x |
| Iraq | ME | x | x | Tuvalu | OC | x | x |
| Ireland | EU | x | x | Uganda | AF | x | x |
| Israel | ME | x | x | Ukraine | EP | x | x |
| Italy | EU | x | x | United Arab Emirates | ME | x | x |
| Jamaica | CA | x | x | United Kingdom | EU | x | x |
| Japan | AS | x | x | United States of America | NA | x | x |
| Jordan | ME | x | x | United States Virgin Islands | CA | x | x |
| Kazakhstan | AS | x | x | Uruguay | SA | x | x |
| Kenya | AF | x | x | Uzbekistan | AS | x | x |
| Kiribati | OC | x | x | Vanuatu | OC | x | x |
| Kosovo, Rep. of | EP | x | x | Venezuela | SA | x | x |
| Kuwait | ME | x | | Viet Nam | AS | x | x |
| Kyrgyzstan | AS | x | x | Wallis & Futuna Islands | OC | x | |
| Lao People's Democratic Republic | AS | x | x | Windward Islands | CA | x | |
| Latvia | EU | x | x | Yemen | ME | x | x |
| Lebanon | ME | x | x | Zambia | AF | x | x |
| Leeward Islands | CA | x | | Zimbabwe | AF | x | x |

Notes: (1) The list of countries in the subset is determined by the availability of the population data (World Bank, 2020a). This subset is used for the concentration and co-agglomeration analysis. (2) Countries can be grouped in nine regions: Africa (AF), Asia (AS), Europe (Non-EU; EP), European Union (EU), Mexico, Central America and Caribbean (CA), Middle East and Arabs States (ME), North America (NA), Oceania (OC), and South America (SA). (3) Belgium and Luxembourg are jointly considered for the analysis in Ch. 2 because some ICO statistics for early years were provided for the two countries jointly. (4) To have a panel dataset for a longer time period, the available statistics for the countries before transformation are distributed to the newly established countries according to the three-year average share of these new countries after their foundation. For example, the trade statistics for Czechoslovakia for 1991 and 1992 were distributed to the Czech Republic and Slovakia for 1991 and 1992, according to the three-year average (1993 – 1995) of each country's share in the trade statistics considered. This applies to Czechoslovakia, USSR and Yugoslavia. (5) The country sets considered for the regression analysis in Chapter 3 are again smaller than the subset listed here due to the limited availability of data required for the set of the independent variables.

Table A2: List of ICO data (ICO, 2020b) used for the analysis in the study

| Statistics | Year period | Unit |
|--|-------------|---|
| Production statistics | 1991 – 2018 | in volume (tsd 60-kg bags) |
| Consumption statistics | 1991 – 2018 | in volume (tsd 60-kg bags) |
| Exports (calculated total, green, soluble and roasted) | 1991 – 2018 | in USD (current and constant) in volume (tsd 60-kg bags) |
| Imports (calculated total, green, soluble and roasted) | 1991 – 2018 | in USD (current and constant) in volume (tsd 60-kg bags) |

Box A1: Technical information about the Ellison-Glaeser co-agglomeration index

To measure the co-agglomeration level between the economic activities considered, the Ellison-Glaeser co-agglomeration index (eq. (A1); see Ellison and Glaeser, 1997; Ellison et al., 2010) is calculated. This index is given by:

$$EG = \frac{\sum_{i=1}^I (x_i - w_i)(\tilde{x}_i - w_i)}{1 - \sum_{i=1}^I (w_i)^2} = \frac{\sum_{i=1}^I (w_i)^2 \left(\frac{x_i}{w_i} - 1\right) \left(\frac{\tilde{x}_i}{w_i} - 1\right)}{1 - \sum_{i=1}^I (w_i)^2} \quad \text{A1)}$$

where $i = 1, \dots, I$ refers to the individual countries. Variables x and \tilde{x} refer to two different types of economic activities considered and are measured in the share of country i in the corresponding economic activities. w_i is the relative weight of country i in terms of population, with the sum of the weight of all countries being equal to one.

Different from the Theil index, the EG index can be positive, zero or negative. A positive (negative) value of the index indicates that the two types of economic activities considered tend to concentrate in the same (different) countries. It has the value of zero, if there is no concentration for at least one of the economic activities considered.