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The Extent of Engagement in Global Value Chains by Firms in Rwanda

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Abstract

Using administrative data for an exhaustive sample of formally registered firms, reveals that the engagement of Rwandan firms in global value chains (GVCs) is remarkably limited. The paper documents several patterns of firm-level exports and compares firm characteristics between exporters and non-exporters. It also illustrates which firm-level characteristics are good predictors for a variety of extensive margins of export and import activities. The analysis includes firms from three goods-producing sectors, agriculture, mining, and manufacturing, but focuses mostly on manufacturing firms. The results indicate large differences between small and large exporters in terms of export market participation, type of products exported, and destinations served. GVC engagement has increased over the 2008–2016 sample period, especially for manufacturing firms, but this is a slow process with frequent set-backs.

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The extent of engagement in global value chains by firms in Rwanda

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JEL codes: N67, F15, F63

1. Introduction

Already 20 years ago, Feenstra (1998) wrote a survey article in the *Journal of Economic Perspectives* on the disintegration of production and the wide-ranging impacts this had on trade flows. Since then, the rise of global value chains (GVCs) has received a lot of research attention, leading to new measurement tools and insights in the development of global production networks.

An issue of particular interest is how this development impacts the way poorer countries are integrated in the global trading network. A relatively upbeat perspective is provided in a series of monographs published by the World Bank, i.e. Hernández, Martínez and Mulder (2014), Taglioni and Winkler (2016), and World Bank (2017).

Others, however, provide a more negative perspective. For example, Whittaker et al. (2010) emphasize that countries that come late to the development challenge now face a process of compresses development. In order to engage with the world economy via the existing global value chains, they need to address a host of challenges simultaneously. The requirement to adjust a wide range of policies at once represents a very challenging task for states; only a few countries are able to accomplish this.

Relatedly, Rodrik (2018) discusses how the importance of GVCs impacts the benefits that developing countries reap from new technologies. While new technologies have direct benefits, they tend to be biased towards skills and other capabilities, and they often reduce the comparative advantage of developing countries in traditionally labor-intensive manufacturing activities. Moreover, GVCs limit the extent to which firms in developing countries can substitute unskilled labor for other production inputs, further limiting their ability to use their labor cost advantage to offset their technological disadvantage.

In this paper we take a resolutely empirical perspective and focus on the performance of individual firms. While it is undeniable that firms in some countries have been able to benefit greatly from GVCs, the rapid development of the Chinese economy is a case in point, not all countries have had the same experience. We study the economy of Rwanda and focus especially on the manufacturing sector, while also presenting some evidence for other tradable goods sectors, namely agriculture and mining.

The unique perspective of our analysis is that we have access to information for the universe of formally registered firms in Rwanda. We have merged information from three administrative datasets at the firm-level: from payroll, business income taxation, and custom's. The exhaustive nature of our data allows us to reach conclusions about the breath of engagement in GVCs for the entire set of active firms.

One important finding that surfaces is the remarkable concentration of exports in only a few firms. Freund and Pierola (2015) already highlighted this pattern for 32 developing countries, but our more detailed evidence for Rwanda highlights this even further. Given that we not only observe international trade engagement at the firm-level, but also employment and sales statistics, we are able to show in what way trading firms are different from firms only active domestically. One surprising finding is that sales per employee, a coarse proxy for labor productivity, is not a predictor of export market participation. That is to say, firms which pay payroll taxes, and thus firms for which we observe formal employment, are

significantly more likely to export. It is only within this select group,[1] of most likely highly productive firms, that productivity has no predictive power.

A second important insight is that the globalization pattern tends to be somewhat different for manufacturing firms than for agriculture or mining firms. In particular, there is a much longer tail of smaller exporters and these firms focus, not surprisingly on trade with neighboring countries. More remarkable is that also the type of products traded by small exporters tend to differ from product categories that dominate the export bundle of larger exporters. As a result, the revealed comparative advantage of Rwandan manufacturing firms is somewhat different between small and larger firms.

We obtain many more detailed insights along the way, but it is hard to summarize them succinctly. The key contribution of this report is to offer a first glimpse of the GVC engagement of firms that represent an exhaustive sample of formal firms in a developing country. This cross-industry overview provides a useful complement to the literature that contains many case studies looking at individual industries or segments within an industry in particular countries.[2]

The remainder of this paper is organized as follows. In Section 2 we present a brief overview of the economy of Rwanda, followed by a discussion of the administrative data in Section 3. The presentation of the results, in Section 4, is organized around eight insights which are discussed in separate sub-sections. In the concluding Section 5, we summarize those insights.

2. Overview of the Rwanda economy

2.1 General

Rwanda is a small, landlocked country in East Africa, neighboring the Democratic Republic of Congo (to the west), Tanzania (east), Kenya (north), and Tanzania (south). It is a densely populated country with 12.2 million inhabitants in 2017. Its economy has performed quite well over the last 10 years, driven to a large extent by important public investment programs. Its GDP expanded from 3.83 billion (in current USD) in 2017 to 9.14 billion ten years later.[3] This amounts to an annual growth rate of 9.1% per year, which is among the better performances in sub-Saharan Africa. The strong economy is also reflected in a declining poverty rate. In 2005, 67% of the population was living on at most $1.90 (in 2011 PPP) per day, but this had declined to 56% by 2013, the last year for which there is comparable data. Still, with a GNI per capita of 1,990 (in PPP, current international $), which is approximately

[1] Only one ninth of the firms that register with the business income tax registration, for which we observe sales, also register as employer, and only in that case do we also observe employment.

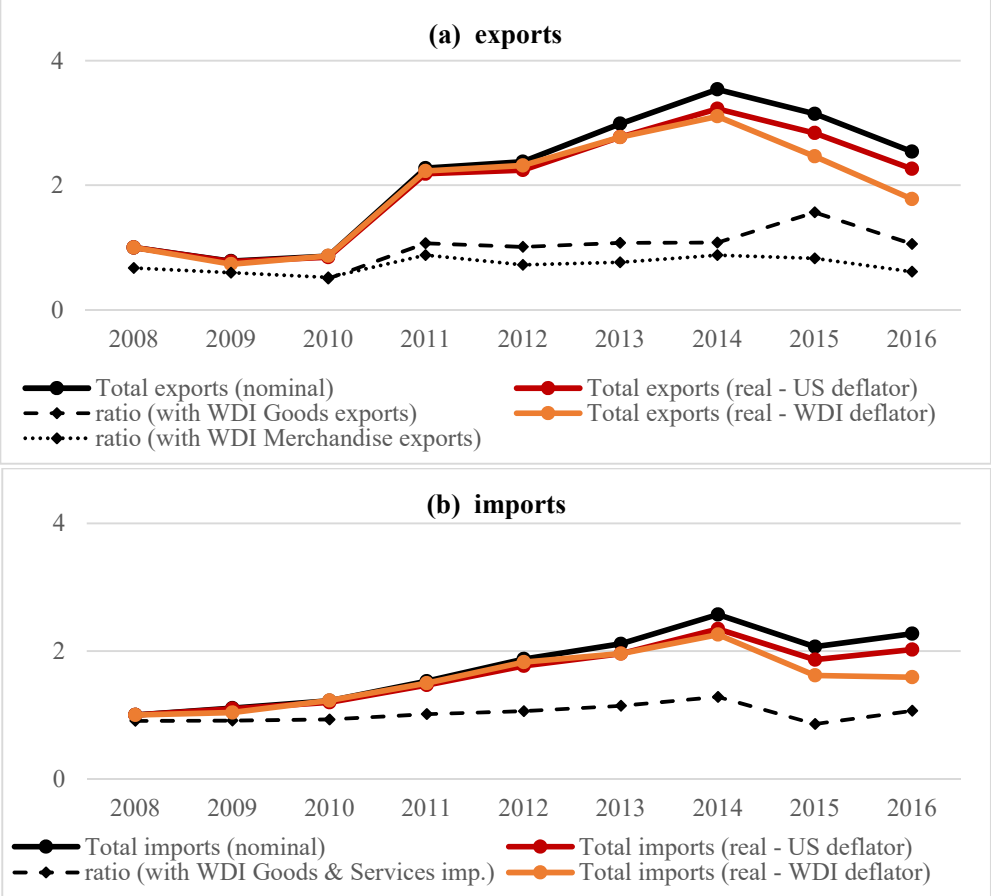
[2] A broad overview of the literature studying GVCs using case studies can be obtained from the list of publications of the Global Value Chain Initiative: https://globalvaluechains.org/

[3] These statistics are taken from the World Bank World Development Indicators online database that can be accessed at http://databank.worldbank.org/data/source/world-development-indicators/.

half of the average income level in sub-Saharan Africa, Rwanda remains a rather poor country.[4]

For our analysis it is important to highlight that aggregate exports have increased rapidly over the last decade. Figure 1 shows the evolution of both exports and imports, calculated by aggregating over all firms in the firm-level sample that we use in our subsequent analysis (which is described in the next section). Both series are normalized at 1 in 2008, the starting period of the data in the firm-level sample. We use two alternative deflators to convert the nominal values that we observe in the firm-level data into real values.[5] Exports approximately tripled from 2010 to 2014 in real value. Imports also expanded rapidly, but they increased only by 120%.

Figure 1: Evolution of aggregate exports and imports



Source: Total exports and imports are constructed by aggregating over the firm-level custom's data. The denominator in the ratios and the WDI deflator are constructed using series downloaded from the World Bank's online World Development Indicators.

[4] The average GNI per capita for all of sub-Saharan Africa, excluding a few high-income countries, was almost double, at 3,680 (current PPP) in 2017.

[5] Only between 2014 and 2016 do the two deflators differ noticeably with the prices in the WDI deflator rising more rapidly than using the US deflator to adjust the trade values that are reported in USD.

The last two years of the sample period shows a decline in trade flows, which coincides with a modest growth slowdown in the domestic economy. There is some question to what extent the lower aggregates are the result of incomplete reporting in the last one or two years. It is possible that not all firm-level information had been included in the database yet when we received the data files. A comparison with information from the World Bank's World Development Indicators (WDI) suggests that some of the trade slowdown could be due to incomplete reporting. The ratio between the firm-aggregates and the WDI statistics declines somewhat from 2015 to 2016 for exports. However, for imports there is some divergence between the firm-level and WDI aggregates between 2014 and 2015, but the two measures converge again in the last year. The possibility of incomplete reporting is something to keep in mind when we look at evolutions over time, but there is no clear break in the last year that would make this an obvious problem.

2.2 GVC aggregates

We next use the information in the EORA global supply chain database that includes a multi-region input-output table, to provide an overview of the GVC integration of the Rwandan economy at an aggregate level.[6] Van Biesebroeck and Mensah (2019) describes how the full table—which contains information for 190 countries over a 26 sector harmonized classification—can be collapsed to construct a country-specific input-output table for Rwanda that shows the interactions of its economy with eight regions in the world.

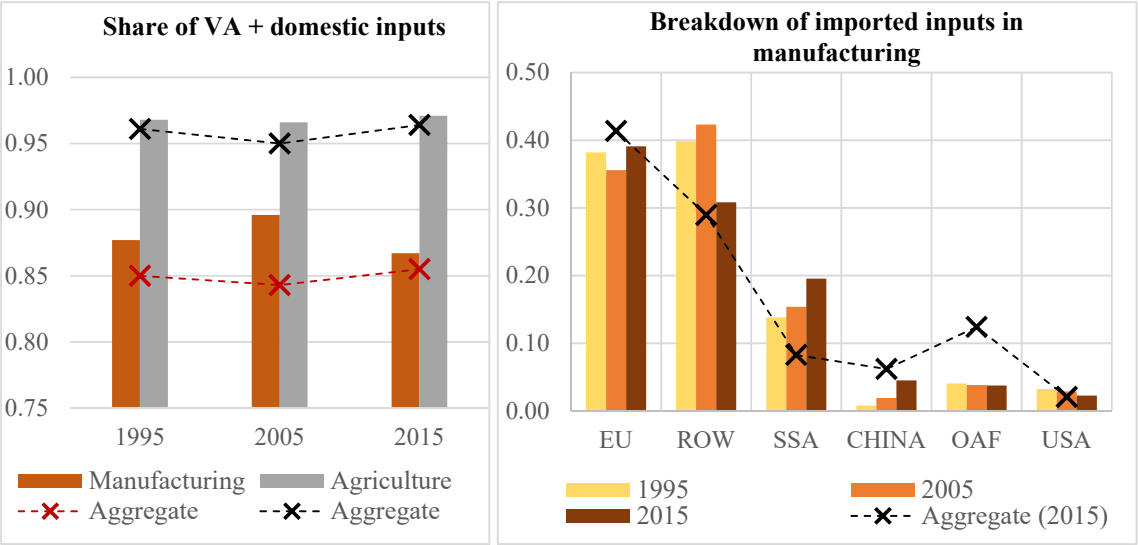
The left panel of Figure 2 illustrates that the agricultural sector of Rwanda operates rather independently from the rest of the world. The share of total output that consists of intermediates sourced within Rwanda itself and value added created in the agricultural sector is around 97%. This high fraction has not changed noticeably over time. It is not surprising that this share is high in agriculture, but this share for Rwanda is higher than for the rest of sub-Saharan Africa, where it fluctuated between 95% and 96.4% over the 1995-2015 period. The share for sub-Saharan Africa is already higher than in other regions of the world, which is a result of the importance of smallholders.

The corresponding share for the manufacturing sector, i.e. the sum of value added and domestically sourced intermediates, was 88% in 1995 and this declined by one percentage points by 2015. Again, the share for Rwanda is higher than for the whole sub-Saharan African region where it was approximately 85%.

The right panel of Figure 2 shows the most important regions in the world from where Rwandan manufacturing firms source their intermediates. The EU has become the most important region with an import share of 39%, while previously the most important origin was the rest-of-the-world (ROW) aggregate. Two regions/countries experienced an increasing share over time. In absolute terms, the other sub-Saharan countries saw the largest increase and in 2015 they provided a fifth of imported inputs. In relative terms, it is the rise of Chinese intermediate inputs that really stands out. This latter trend is shared by every single country on the continent and Rwanda is lagging slightly behind, sourcing only 4.5% of inputs from China, while the regional average is 6.2% in 2015.

[6] This full EORA data is available online at http://worldmrio.com/

Figure 2: Patterns in intermediate input sourcing at the aggregate level



Notes: Own calculations based on the EORA data.

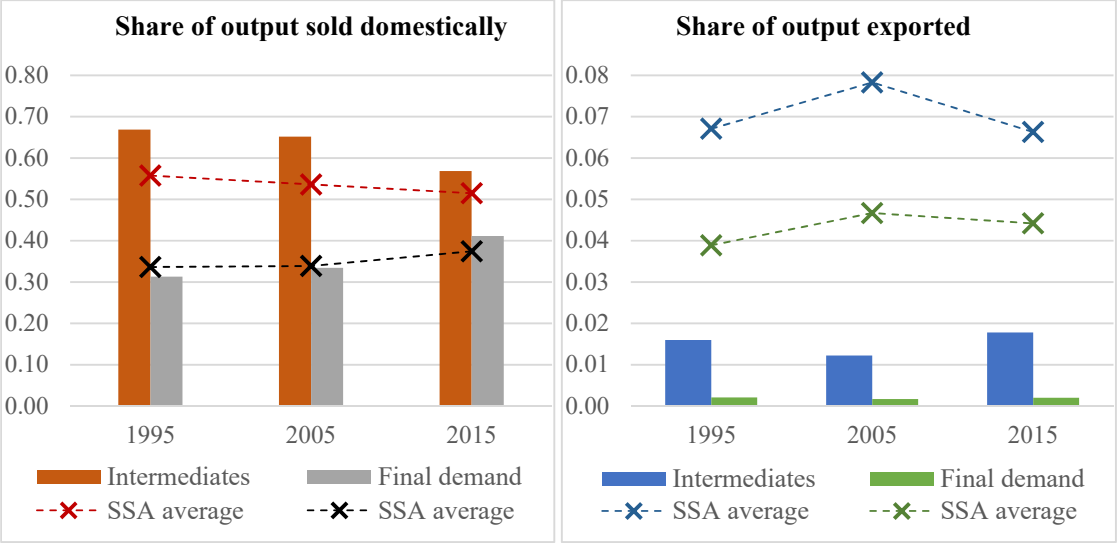
Perhaps surprising is the small and declining share of parts sourced from the United States, which in 2015 only accounted for 2.3% of imported inputs and 0.3% of the full output value. However, this is very much in line with its low importance for the majority of countries in the region. Other African countries (OAF) are much less important for Rwanda than for the average country in the region, but that is intuitive given its relatively large distance from both South Africa and the Northern African countries.

From the information in the rows of the country-specific input-output table for Rwanda, we can learn where its firms sell their output. In Figure 3 we show the results for manufacturing products. On the left, we see that domestic sales in the form of intermediate inputs to other sectors is the most important category, but its importance has gone down over time. The second most important category are domestic sales to final demand, which has picked up the share lost by domestic intermediate input use. In 2015, these two components absorb 57% and 41% of manufacturing output, while only a paltry 2% is exported.

The panel on the right shows exports, but note that the scale of this graph is 10 times smaller than on the left. Virtually all manufacturing exports of Rwanda are intermediate inputs. The importance of exports has increased ever so slightly, from 1.8% in 1995 to 2.0% in 2015, but remains much lower than in the rest of sub-Saharan Africa where exports account on average for 11% of manufacturing output. The overall integration of Rwanda in GVCs remains very limited.

The share of agricultural output that is exported is higher than for manufacturers, but the difference is remarkably small. In 2015, 80% of all agricultural output is sold as intermediate inputs to other sectors in Rwanda (mostly to the food processing industry), while 13% goes directly to domestic final demand. Only 2.8% is exported to Europe, 0.6% to Africa, China, or the United States, and 3.4% to the rest of the world, combining intermediate inputs and final demand.

Figure 3: Destination of manufacturing output



Notes: Own calculations based on the EORA data.

In sum, the economy of Rwanda is even less well integrated with international markets than most sub-Saharan African countries. On the output side, manufacturing firms export only 2% of output, compared to 11% for the rest of the region. More of its agricultural output is exported, but at 6.8% that fraction is still much lower than the 25.4% that is the average for the region. On the input side, the difference is smaller: 13.3% of inputs in manufacturing are imported, which is similar to the 14.5% average for the region. Inputs to agriculture are almost all sourced domestically, but the same pattern prevails in the rest of the region.

The objective in the remainder of the paper is to investiage what this aggregate exposure implies at the firm level. How many firms are internationally engaged, which firms, and to what extent? Of the firms selling or sourcing internationally, what regions are they mostly exposed to and what products are they producing? To answer these questions, we work with an exhaustive dataset of all formally registered firms in Rwanda that is introduced in the next section.

3. Data

This project uses administrative, micro-level data for Rwanda that includes information on the universe of registered firms from three different sources of administrative data:

- Trade-transactions data from custom's: Imports & exports by firm-year in both value and quantity terms, broken down by product (HS 8-digit) and partner country. While this is recorded at the transaction level, it is aggregated to yearly totals.
- Payroll data: Number of employees and total wage bill. These are the reports provided to the payroll authority for the purpose of reporting wages and paying payroll tax. This dataset should be seen as representative of the universe of registered firms that have payroll, i.e. formally employ workers beyond the owner.

- Income tax data: this includes many variables, including a description of the firm's activity, revenue, profits, taxes, tax credits, inventory, cost of goods sold (basically all variables from a standard income statement). Because most variables are not reported very well, except for the larger firms, we will focus on sales as a measure of total firm size. This dataset is the universe of registered firms in Rwanda and includes both firms that do or do not have any employees, such as sole entrepreneurships.

These three datasets are merged using the unique taxpayer identification number assigned to the firm. The trade information contains the largest number of unique observations, but not all of them are formally registered firms.

We observe the information in all three data sources for a panel of firms over time, which allows for both a cross-sectional and growth analysis. The sample period starts in 2008 and goes to 2016. The coverage of the payroll and tax data tends to grow over time, but the overall number of firms surveyed is quite limited. This is not unexpected as the administrative information only covers firms in the formal sector. Aggregating over the three goods producing sectors that we focus on—agriculture, mining, and manufacturing—we observe employment for an average 321 firms in each year (of which 42% are from manufacturing). Firm sales is much more widely reported, and across the three sectors we observe an average of 2,926 firms in each year (30% from manufacturing).

The aggregate statistics already showed that engagement in GVCs is rather limited for this small, landlocked country. The administrative data illustrates directly that even the total number of registered manufacturing firms is remarkably small. But that is simply the reality in many economies dominated by the informal sector. It also presents an unavoidable challenge for policy as formal registration is likely to be a first step before firms can start integrating in GVCs.

By construction, our data will miss a limited volume of cross-border economic activity by smaller firms that goes unreported. This is especially prevalent in agricultural products, but also in manufacturing there likely is a trail of smaller, informal firms that make small sales in neighboring countries.

4. Results

Our empirical results are organized around eight important messages that we want to highlight. We summarize them at the end, but in the following sub-sections we first discuss the supporting evidence in detail.

4.1 Few firms are globally engaged

We first document the absolute number of firms that export as well as its increase and the growth in absolute export volumes. For this analysis, we use an export threshold of 10,000 USD per year. We exclude smaller exporters for two reasons. First, the customs data also includes trade flows for individuals and firms that export idiosyncratic (often personal) items without really being in that line of business. There is no way to differentiate them from firms that would are indeed producing the items, but are simply not (yet) successful at exporting. Second, we cannot be certain that the registered firms in our dataset represent an exhaustive

overview of the smallest exporters, while the customs data is likely to be much more exhaustive. As a result, the export propensity calculated for the smallest size class of firms is likely to provide a misleading pattern. Note that from Section 4.3 onwards, when we study the export destinations and product concentration, we lower the threshold to 1000 USD per year.

The number of globally engaged firms in Rwanda has trended up noticeably over the 2008 to 2016 sample period, as depicted in Figure 4. This growth is broadly based, showing up in the three major sectors that we consider—agriculture, mining, and manufacturing—and using various thresholds to identify globally engaged firms. Overall, only 43 firms exported more than 10,000 USD in 2008 and this increased to 101 in 2016, which represents an increase by 135% over 9 years.

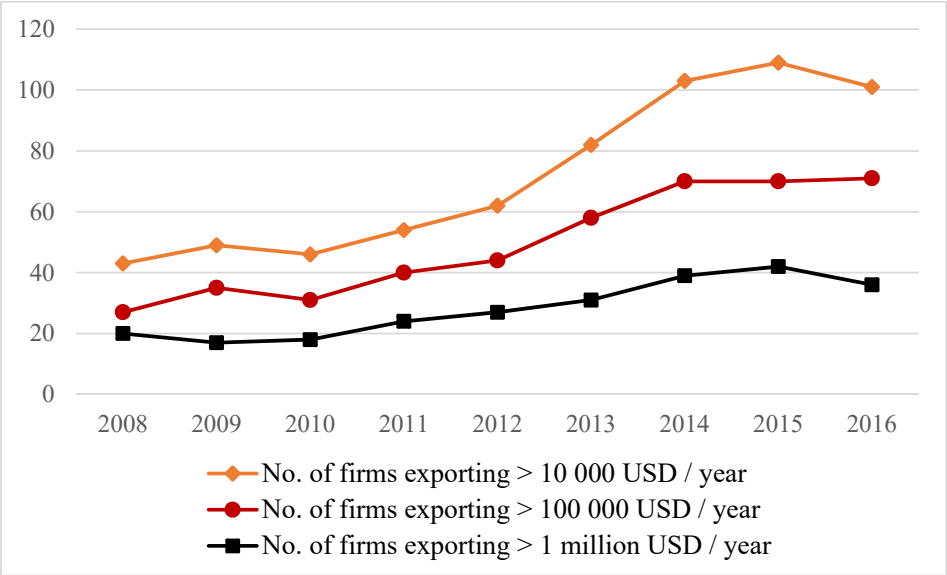
In spite of this increase, the total number of exporters is still remarkably low, even in 2016. This is especially true considering that the total of 101 includes all firms selling a mere 10 000 USD per year. This total amounts to a single exporter per 120,000 inhabitants or one exporter per 91 million USD of GDP.

The number of exporters grew strongly after the latest global recession (in 2009), more than doubling from 2010 to 2014. In more recent years, the growth has stalled and in the last two years of the sample period the total number of globally engaged firms even declined. It is more likely to be the result of civil unrest in Burundi and armed violence in the DRC in 2015 and 2016, than because of incomplete reporting in the most recent years. We base this conclusion on several pieces of evidence. First, aggregate statistics for our sample line up rather well with the aggregate data from the World Bank. Second, in conversations with manufacturers in Rwanda, they often highlighted the troubled political situation in the two neighboring countries. Third, results in tables below show that the decline in the last two years is most pronounced for manufacturers, which are more likely to export to neighboring countries than agriculture or mining firms.

If we used a threshold that is 10 times higher, i.e. exporting 100 000 USD per year, only 71 firms in Rwanda would qualify as globally engaged by 2016. While this is lower than earlier number, it is not that much lower given the 10-fold increase in the threshold. It highlights that very few firms export more than 10,000 USD, but less than 100,000 USD. In more developed countries, we expect a power law, meaning that the number of firms that export 10 times as much would be 10 times smaller (or some other proportionate decrease). This is clearly not the case in Rwanda. Among the 101 firms that exceed the 10,000 USD threshold for exports, more than one third even exceed the 100-fold higher threshold of exporting at least 1 million USD per year, depicted by the black line in Figure 4.

A potential explanation for the rather limited number of firms that export small quantities is that fixed cost of exporting are important. This mechanism features prominently in the seminal paper of Melitz (2003) to explain export market participation. Only firms that are sufficiently productive and that can reasonably expect to export a sufficiently large amount, find it worthwhile to incur the necessary fixed outlays to enter the export market. These fixed costs can be related to transportation infrastructure, searching for potential clients, adjusting the product to foreign market, familiarizing oneself with customs procedures, etc.

Figure 4: Number of firms that export a non-negligible amount



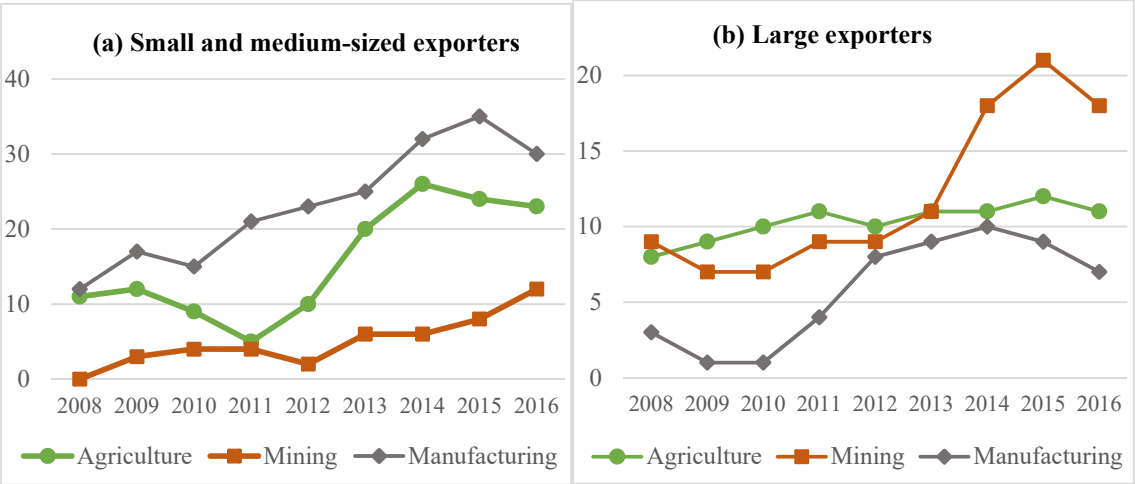
Source: Statistics in this an all following figures and tables are calculated on the firm-level dataset that is constructed by merging administrative information from three data sourced that covers the universe of registered firms in the agriculture, mining, and manufacturing sectors of Rwanda (for details see description in the data section).

In this perspective, it can be considered a positive development that the ratio of small to large exporters has increased over time. In particular, while the number of firms that exported more than 1 million USD grew from 20 to 36 over the 9 year sample period, the number of firms that exported less than 1 million USD almost tripled, increasing from 23 to 65. This can be seen directly from the widening gap between the black and the orange lines in Figure 4.

We show the number of small and large exporters separately by sector in Figure 5. Not surprisingly, the number of large exporters, i.e. firms that sell more than 1 million USD abroad in a year, is relatively stable over time. The right panel of Figure 5 barely shows any change for agricultural firms, rising from 8 firms to a maximum of 12 in 2015. The pattern is similar for mining firms between 2008 and 2013, but in the last three years the number of large exporters suddenly jumped. Quite remarkably, only a single manufacturing firm managed to sell more than 1 million USD abroad in 2009 or 2010, but this became a little more common over time. In 2012 and 2013 all three broad sectors counted approximately 10 large exporters, but since then the sectoral experience diverged again. But unless the sudden increase in large mining exporters proves durable, it seems that the three sectors are converging somewhat.

The importance of the three sectors is notably different for small and large exporters. In fact, the relative importance of the three sectors is exactly reversed if we focus on smaller exporters. In the mining industry, there are more firms exporting more than 1 million USD than firms exporting less than this amount. This is especially remarkable given that Rwanda's mining industry specializes in high-value minerals that are extracted and exported in relatively low quantities. If mining were mostly concentrated in large-scale extraction of basic ores using a highly capital-intensive process, a high market concentration would be expected. However, the most important mining exports for Rwanda are tin ore, coltan, wolfram

Figure 5: Number of small and large exporters (by sector)



(tungsten), and tantalum, for which total production is counted in a few thousand tons.[7] In Rwanda's case, it is more likely that the industry concentration stems from government regulation and interventions. The number of small exporters of mining products did increase rather rapidly from 2 in 2012 to 12 in 2016.

Note that the scale on the vertical axis for the left panel of Figure 5 (for small exporters) is twice as large as on the right (for large exporters). As a result, the figure obscures the fact that the agriculture sector at the end of the sample period counts twice as many small exporters than large exporters. While a more natural, and arguably more economically healthy situation, even that ratio implies a rather strong concentration. In manufacturing, there were 4 large exporters for each small exporter in 2016.

It might be that phyto-sanitary standards impose barriers to exports of agricultural products, but we doubt this is the main reason that we observe so few small-scale agriculture exporters. Standards are certainly present for exports to Europe, but only large firms target those markets. They could play a role for exports to Uganda or Tanzania, but we would expect the smallest agricultural exporters to target Burundi or the DRC, where product standards are non-existent or weaker than in Rwanda.

In both the agriculture and manufacturing sectors we had, a priori, expected to observe many more small exporters. Family farms are the predominant economic activity in the country. In the informal manufacturing sector there are many tailors or seamstresses working out of their homes. However, the majority of small-scale agricultural exports to neighboring countries are unlikely to be captured in the Customs data that we work with and the same is likely to be true for small manufacturing exports.

In our dataset there are additional export transactions conducted by firms with less than 10,000 USD total exports in a given year. In many instance, when such export transactions are

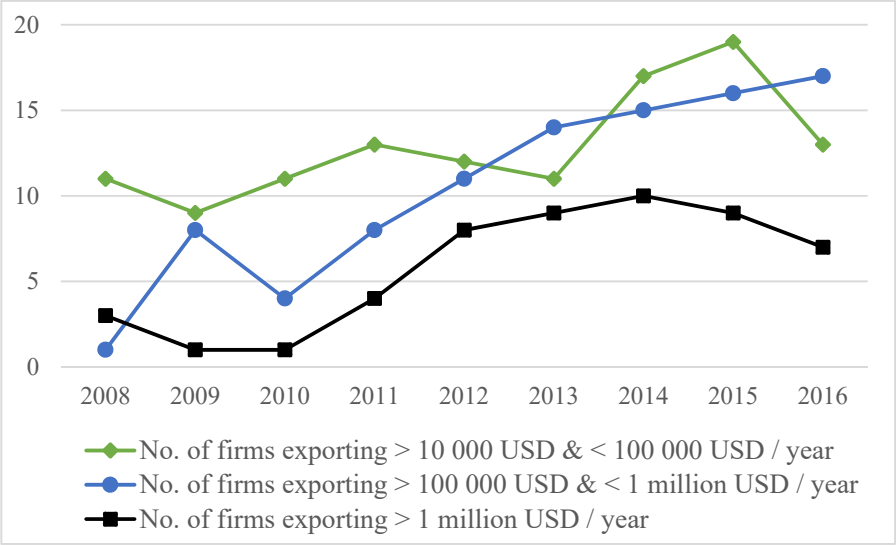
[7] A few basic production and export statistics are provided at https://en.wikipedia.org/wiki/Mining_in_Rwanda.

recorded in the custom's data, the exporter is not registered with the government and does not show up in our other two data sources. As we only know a firm's sector when it has a taxpayer identification number (TIN), with the tax authority for business income tax or for payroll tax purposes, we omit exporters and importers without a TIN. Because most of the small exports are by entities without a TIN, we omitted them entirely from our calculations as the few included observations with a TIN would not provide a faithful representation of the universe of small-scale trade transactions. Moreover, we also imposed a 10,000 USD per year threshold, because firms exporting less than even this minimal amount cannot really be considered to be participating in an international value chain in a substantive way.

In Figure 6 we show the evolution for the distribution of exporters from the manufacturing sector separately for the three exporter-size categories. A few patterns are worth mentioning. The decline towards the end of the period, mentioned earlier, is strongest for small firms. Even though small-scale manufacturing firms are more likely to be registered with the government than small-scale agricultural firms, this is unlikely to be the primary reason for the larger number of small manufacturing exporters. The growth in number of manufacturing exporters is even more pronounced for firms exporting at least 100 000 USD per year, which makes it likely that the different evolution from agriculture is not merely a registration issue. Even agricultural firms exporting this much are highly likely to be formally registered.

Manufacturing seems to be a sector where exporters of all three sizes seem to be viable. While small mining firms only appeared later in the period, the reverse is true for manufacturing. In 2008-2010 there eleven small exporters, but only two large ones. All categories expanded by 2014 and at relatively similar rates. By 2014 there were ten large manufacturing exporters, which is consistent with a more natural evolution of successful firms thriving and gradually expanding. Also, manufacturing is the only sector where the firm frequency varies inversely with firm size. This ordering does not hold strictly in every year, but hold in average. In 2013 and 2015 there were more medium-sized than small manufacturing exporters, but this was caused by greater volatility in the number of small exporters, which itself is quite natural.

Figure 6: Number of manufacturing exporters by size



The number of exporters is clearly very low, but it is hard to compare with other countries because similar administrative data is rarely available. As a basis of comparison, we can compare the export propensity of Rwandan and other African firms in the World Bank Enterprise Surveys (WBES), see Van Biesebroeck and Mensah (2019) for details on that dataset. In the case of Rwanda, 9.0% and 9.5% of surveyed firms report to be exporting in, respectively, the 2006 and 2011 surveys. The average across other sub-Saharan African countries is 10.6% in both years, but 15.5%, which is quite a bit higher, over the full 1992-2018 period. However, limited to firms in the manufacturing sector the export propensity is 22.9% in Rwanda, which is barely distinguishable from the full sample average over all African countries of 22.1%. However, the two survey years count respectively 13 and 19 exporters for Rwanda. It would suggest that either almost all formal firms are included in the WBES survey or the administrative data misses some exporters.

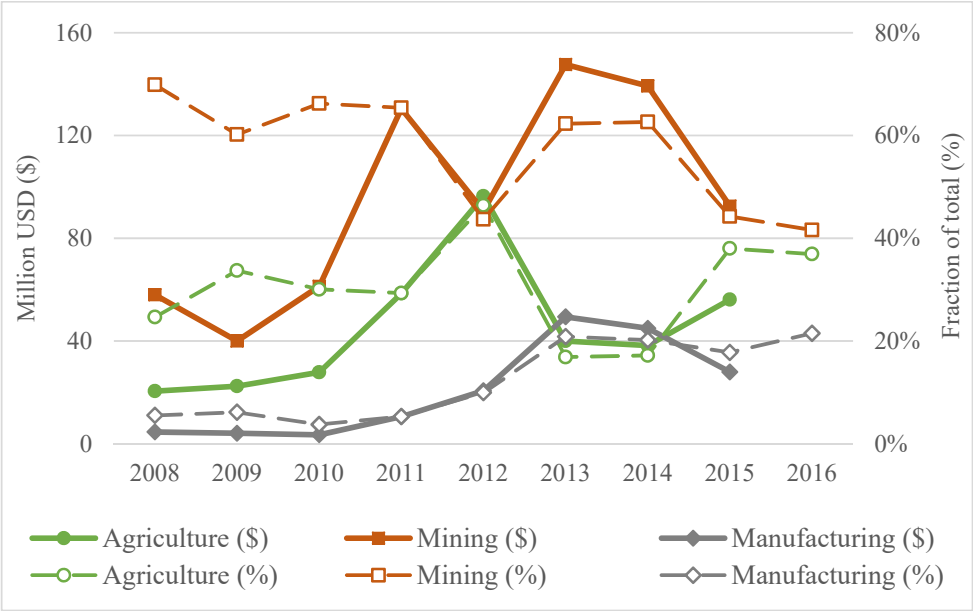
4.2 Trade in manufacturing products is becoming relatively more important

Not only the number of firms has increased over the sample period, the same is true for the absolute export volumes. The solid lines in Figure 7 show rising export values for all three sectors. The absolute growth is most pronounced for the mining and agriculture sectors, but both sectors also experienced large downturns. We only plot the absolute exports to 2015 as the aggregates are lower in 2016 and we cannot rule out entirely that this is at least partly due to incomplete recording at the time when we received the data.

Comparing average exports in the first two years (2008-2009) to the last two years (2014-2015), exports have increasing by 67 million USD for mining and by 32 and 26 million USD for agriculture and manufacturing. The percentage increase shows a rather different pattern as the initial export volumes differed a lot by sector. Exports more than doubled for agriculture and mining, growing by 120% and 137% from the first two to the last two years. Manufacturing exports, however, soared by almost 750%. It highlights both the very low base of manufacturing exports ten years ago, but also the growth potential. If not for the civil unrest in neighboring countries, the performance at the very end of the sample period would most likely have been even better. Apart from the decline at the end, the export evolution is least volatile in manufacturing.

The growing importance of manufacturing exports is also apparent from the dashed lines that show the relative share of the three sectors in the total. Given that incomplete reporting is likely to affect all sectors similarly, this series is shown up to 2016. Over the 9-year period that we observe, the manufacturing export share rose from 6% to 21%. And this was in a context of rapidly rising exports for the other sectors as well. Of course, the impact of this evolution should not be overstated as even in the final years manufacturing only accounted for less than one fifth of total exports and its share stopped increasing in the last three years.

Figure 7: Evolution of export volumes and share for different sectors



Note: The solid lines show absolute export volumes (in USD) on the left-scale; the dashed lines show the relative share of the three sectors in the total (in percentage) on the right-scale. We do not report the absolute export volumes in 2016. These are notably lower for all three sectors, but we are uncertain to what extent this is due to incomplete reporting or an accurate reflection of the export evolution.

But the greater relative importance of manufacturing is a welcome evolution for several reasons. The upside potential is less likely to be capacity constrained than in the other two sectors. Compared to mining in particular, the greater labor intensity of manufacturing is good for the employment potential. Prices tend to be less volatile than in agriculture or mining and the aggregate export volumes shown in Figure 7 are least volatile for manufacturing. The more broadly based export market participation that we documented for manufacturing in Figures 5 and 6 can be one factor contributing for the greater stability. Exports in the other two sectors are more sensitive to idiosyncratic firm-specific successes or failures.

Using the sectoral data from EORA we can construct the growth rate in the share of output that is exported for the three sectors. For agriculture and mining the trend is not positive. The share expanded from 1995 to 2005, but contracted from 2005 to 2015. For manufacturing there is an increase from 2005 to 2015, but the share only goes from 1.4% to 2.0% of output which is barely higher than the share already attained in 1995 which was 1.8%. Of course, the aggregates in EORA includes the output of smaller firms and probably also an estimate for the informal sector where exports are likely to be negligible.

It is difficult to compare our findings for Rwanda with other countries because administrative data that covers all firms is rarely available. Ethiopia is one country with a high quality manufacturing firm census that several researchers have used. Recently, Siba and Gebreeyesus (2017) report that in 2008-2009 (the last year in their sample) only 4.0% of the Ethiopian manufacturing firms show positive exports.[8] While the share of exporters did not

[8] Note that their sample only includes medium and large firms with at least ten employees.

really increase from 1995 to 2009, the number of firms in the census approximately tripled, while the fraction of exporters remained constant. As a result, the absolute number of manufacturing exporters increased from 24 to 78. But even that last number is proportionately smaller than for Rwanda, given that at the time the Ethiopian economy was approximately eight times larger.

4.3 Smaller exporters are only important in manufacturing

After an overview of GVC integration for the entire manufacturing sector, the number of exporters, and the evolution of total trade, Table 1 provides evidence how this aggregate breaks down by destination and firm size along a variety of dimensions. First, and most importantly, for each of the three sectors it shows the top 5 export destinations. Second, by comparing the results over time we learn about the evolution of global integration. Third, the shading in the table indicates how much difference it makes when we include small exporters. Darker colors indicate greater importance of small firms. Fourth, cells are given a black border if the rank of an export destination depends on the inclusion or exclusion of small exporters in the total.

We first discuss the relatively low importance of small exporters. The totals in Table 1 include every firm that exports at least 1,000 USD annually, combined over all its exports destinations.[9] The threshold to be labelled a small or large exporter is 1 million USD. When a cell in Table 1 is not colored, it indicates that bilateral trade would be less than 1% higher if small exporters are included in the total for the cell. Given the earlier figures, it is no great surprise to learn that including sales from smaller exporters makes no difference at all for the mining sector. There are only 3 of the 50 year-destination pairs where the aggregate increases by more than 1% if firms exporting less than 1 million USD per year are included, and even in these few cases the aggregate is raised by less than 5%. No single cell has a black border, indicating that including small exporters never changes the ranking of a destination.

For agriculture exporters, more cells are colored, but even here the changes are remarkably small when we include small exporters limited. Note that we use a very high threshold to distinguish small and large exporters. To be classified as a large exporter a firms need to export a not insignificant fraction of total Rwandan exports, which limits the number of large exporters to only 13 in 2008 (for all sectors) and to 30 firms in 2016. Clearly, it would be difficult for smaller exporters to change the aggregate for the top-ranked destination that generally receives 30 to 70% of all exports, but even exports to the fourth and fifth destinations are only lightly affected. Given that many of the top-5 destinations for agriculture and mining are developed countries, they might simply be out of reach for smaller firms. We discussed this at greater length in the next section.

One notable pattern is that in the second half of the sample period, the importance of smaller exporters in the agriculture sector increased. In the last four years there are few blank cells and even six instances where the aggregate changes by 5% (in two cases even more than 20%) if small exporters are included.

[9] Note that we now use a lower export threshold than in the previous figures as explained earlier.

Table 1: Top 5 destinations by sector

	1st destination	2nd	3rd	4th	5th	Share of 1st destination	Share of 5th destination
(a) Agricultural, Fishing and Forestry							
2008	Kenya	Swaziland	Switzerland	Germany	Belgium	56%	7%
2009	Kenya	Swaziland	Belgium	Switzerland	Uganda	56%	5%
2010	Kenya	Switzerland	USA	Germany	Belgium	45%	6%
2011	Switzerland	Kenya	USA	UK	Germany	31%	5%
2012	Kenya	Switzerland	USA	UK	Germany	67%	2%
2013	Kenya	USA	Switzerland	UK	Netherlands	51%	5%
2014	Kenya	USA	Switzerland	UK	Singapore	53%	4%
2015	Kenya	USA	UK	DRC	Germany	70%	4%
2016	Kenya	USA	DRC	UK	Singapore	58%	6%
(b) Mining, Quarrying and Oil							
2008	Hong Kong	Belgium	South Africa	UK	Swaziland	31%	12%
2009	Hong Kong	Swaziland	Belgium	UK	China	37%	7%
2010	Switzerland	Hong Kong	Swaziland	Belgium	China	44%	7%
2011	Switzerland	France	China	Belgium	Hong Kong	41%	9%
2012	Switzerland	France	Belgium	China	Hong Kong	46%	6%
2013	Switzerland	Malaysia	Hong Kong	Belgium	Kazakhstan	58%	8%
2014	Austria	Switzerland	Malaysia	Singapore	USA	36%	9%
2015	Switzerland	UAE	Hong Kong	Singapore	USA	31%	10%
2016	UAE	Switzerland	Hong Kong	Singapore	Malaysia	58%	4%
(c) Manufacturing							
2008	DRC	Burundi	Netherlands	Italy	India	44%	5%
2009	DRC	Burundi	Spain	Uganda	USA	58%	7%
2010	DRC	Burundi	Switzerland	Uganda	Tanzania	54%	1%
2011	Burundi	DRC	Switzerland	Uganda	Kenya	37%	6%
2012	DRC	Burundi	Uganda	UK	Singapore	55%	5%
2013	DRC	Burundi	Italy	Uganda	Kenya	82%	2%
2014	DRC	Burundi	Italy	Uganda	Kenya	80%	3%
2015	DRC	Kenya	Burundi	China	Uganda	78%	3%
2016	DRC	Kenya	Burundi	USA	Uganda	60%	4%

Notes: The shading of destinations reflects the percentage difference it makes for their total exports whether exports of firms with annual exports below 1 million USD (but above 1,000 USD) are included:

- White: exports are less than 1% lower if small exporters are excluded
- Yellow: exports are 1-4.9% lower
- Orange: exports are 5-19% lower
- Red: exports are more than 20% lower

Cells have a black border if the identity of the destination would be different if small exporters are excluded. In most cases this would only change the ordering of the destinations listed.

The difference with the situation in manufacturing is stark. In the bottom panel of Table 1 almost all cells are colored. In many cases they are even red, which means that the aggregate increases by more than 20% if the contribution of small exporters is included. In the second half of the sample period, total exports for manufacturing rival those for agriculture and even here it remains very important for the aggregates to include sales by smaller exporters.

Moreover, cells receive a black border if the identity of the export-destination for a particular position would change if small exporters are included. For mining this was never the case and for agriculture it only changed the destination country in four cells. In the manufacturing sector, almost half of the top-5 destination identities are different if the contribution of small exporters were excluded. In most cases this would only change the ordering of countries, but in a few cases it even introduces a new country in the table. The most important pattern is that without small exporters the ranking of Uganda would often be lower and in a few years also for Kenya. Ignoring smaller exporters would underestimate the importance of regional trade in manufacturing products. A pattern that is explored further in the next section.

In the Rwandan firms surveyed in the WBES, the median exporter reports to be exporting 160,000 USD a year, or 10% of its total output. The average export value is nine times as large, which underscores the very skewed distribution. This value has decreased slightly from the 2006 to the 2011 survey year. Across all other African countries, the median export value across all exporters is notably higher at 244,000 USD and the mean is far higher still. Omitting the 1% largest export flows because they might be misreported, the average export value over all non-Rwandan firms is 30.1 million USD or more than 100 times the median value. The low values for Rwanda are not inconsistent with the results in the administrative data and they are also low relative to other African countries.

4.4 Export destinations: local and concentrated

It is well-known, see for example Bastos and Silva (2010), that product quality varies across export destinations. Richer consumers in more developed countries have stronger preferences for higher quality products, and firms naturally can charge higher prices in high-quality segments. There is evidence suggesting that such variation is not only the result of firms specializing by market, but it is also driven by firms tailoring their products and prices to the destination market (Fafchamps, El Hamine and Zeufack, 2007). The identity and range of export destination markets also provides information on the extent firms are integrated in GVCs.

A first thing to note from Table 1 is that with only the top 5 destinations we cover the vast majority of exports. For many EU countries, exports to the four largest member states and one or two neighbors cover half of their total exports. For Rwanda, we see that the concentration is even more pronounced. The share going to the top destination is never less than 30% of overall exports in a sector. The fifth destination only accounts for 4% (Manufacturing), 5% (Agriculture), or 7% (Mining), averaged over the sample period. The overwhelming majority of exports, almost always more than 90% and in many cases more than 95%, goes to at most five destinations.

For manufacturing, we expanded the table to include exports up to the tenth destination (results available upon request). On average, the tenth destination accounts for only 0.6% of total exports. If we re-compute Table 1, but only consider firms with less than 100 000 USD annual exports (globally), there are several years when fewer than five destinations are served across all firms in Rwanda.

In sum, concentration by destination is remarkably high. Of course, this pattern is exacerbated by showing the top 5 destinations separately for the three sectors. Comparing the export destinations across the three sectors shows clearly that the overlap is remarkably small. In 2008, only Swaziland and Belgium appear for more than one sector. By 2016 there has been some convergence, as Kenya, the United States and the DRC appear among the top 5 destinations for both agriculture and manufacturing, but among the most important export destinations for mining firms, only Singapore just make the top 5 in agriculture. As a results, the concentration across destinations would be a lot less pronounced if we calculated it for all exports for the entire economy. We showed it by sector because the type of products exported and the nature of the local economic activity is rather different across these three sectors.

Moreover, the aggregate would be dominated by mining and this is not the sector we are most interested in. For agricultural exports, Kenya is by far the most important destination, but most other top-5 destinations are outside of Africa. Even Kenya is not a neighbor and is quite a bit richer than Rwanda in terms of GDP per capita. Serving this export destination is likely to involve overcoming some barriers in terms of logistics requirements and product standards. Given that Rwanda is a landlocked country, it is not impossible that some exports that are recorded to Kenya will be re-exported to destinations beyond Africa.

Another noteworthy fact is the relatively large churn among destinations. Apart from Kenya, all other top destinations of agricultural exports in 2008 do no longer make the list in 2016. In the first two years Swaziland featured in the top-5 list for agriculture exports, as the only other African country, and in the last two years the DRC appeared. There have definitely always been small-scale export transactions in the Rwanda-DRC border regions. The fact that there are now also formal export flows from registered exporters to the DRC is a positive development as the growth potential for exports to that country is very high and the market is relatively accessible, even for smaller firms. It is not surprising that in both instances, the exports to the DRC are substantially higher if small exporters are counted.

Not surprisingly, the importance of African export destinations is even lower for mining exports. Swaziland & South Africa did show up among the top 5 in 2008-2010, but no African countries feature anymore form 2011 onward. As mining exports are less concentrated by destination—note that the fifth destination on average still receives 7% of exports—some lower-ranked African countries might still receive non-negligible mining exports. Mining exports from Rwanda really have global reach: Belgium, South Africa, Switzerland, UK, France, Malaysia, China, USA, Kazakhstan,… The churn in the list is again remarkable. Even some countries that consistently feature on the list, such as Hong Kong, occupy very different positions over time. Only Switzerland consistently features at or near the top.

Not only the coloring, but also the patterns in Table 1 are very different for manufacturing than for the other two sectors. The DRC is the most important export destination throughout almost the entire period, only in a single year it placed second. Burundi, another of Rwanda's neighbors, is always in the top 3. From 2009 onwards, Uganda is always in the top 5 as well, and Kenya shows up in the list at the end of the sample period, from 2014 onwards. Not only are exports exceedingly local, the share of total exports accounted for by these neighboring countries is much higher than in the other sectors. It is highly unlikely that much of this represents entrepot trade and that goods are sent on to further destinations.

In interviews, managers of manufacturing firms in Rwanda indicate that proximity and lower transport costs is their "comparative advantage" and hence they focus on domestic trade or exports to Burundi. This might be surprising at first, because manufacturing exports are more diversified across firms and idiosyncratic demand shocks might be more important. However, many of the additional exporters in the manufacturing sectors are likely to be only marginal exporters. They are much more likely to only clear the lowest export thresholds, for the closest, most accessible markets, consistent with the generalization of the Melitz-model to multiple countries in Chaney (2008). It is also important to keep in mind that manufacturing exports started from a very low base at the start of the sample. The greater importance of richer, but more distant sub-Saharan African countries with more developed manufacturing sectors, like Kenya and Uganda, only in later years coincides with the boom in manufacturing exports.

The importance of African countries as trading partners contrasts sharply with the limited exports going to sub-Saharan African countries, as reported in Van Biesebroeck and Mensah (2019). Using sectoral input-output data from EORA, they find that in 2015 the average country exports 23% of its manufacturing exports within the region. For Rwanda specifically, the EORA data shows that only 2% of manufacturing output is exported. More than 80% of exports are recorded as going to the "rest of the world" and only 8.2% are exported within Africa. This seems highly implausible and suggests that one should be careful with the rest of the world residual category in the EORA dataset.

As has been mentioned a few times already, the results in Table 1 also suggest that a more stable situation in the DRC could really help Rwanda. From 2010 to 2014, as its neighbor was booming, manufacturing exports grew from 3.5 million USD to 45 million USD. At the same time, the share of manufacturing exports going to the DRC averaged 80%. The end of the growth spurt in the DRC in 2016, and the unstable situation in its border region with Rwanda, had an adverse impact on the manufacturing sector in Rwanda and in particular reduced exports.

Figure 1 summarizes for manufacturing the differential exposure of small versus large exporters to nearby versus distant export markets. In order to consider all countries neighboring Rwanda, we consider all top-10 export destinations, which includes all four neighbors in all years. In order to show the specialization of firms that are relatively small even in light of the lack of development of Rwanda's manufacturing sector, we now set the large versus small exporter distinction already at a threshold of 100 000 USD global exports per year.

The pattern that emerges is that exporter size and destination distance are inversely correlated, consistent with economic theory. Moreover, the correlation has become stronger over time. One could interpret these as the results of falling market access barriers (fixed costs of exporting), which are likely to affect small firms and nearby markets the most.

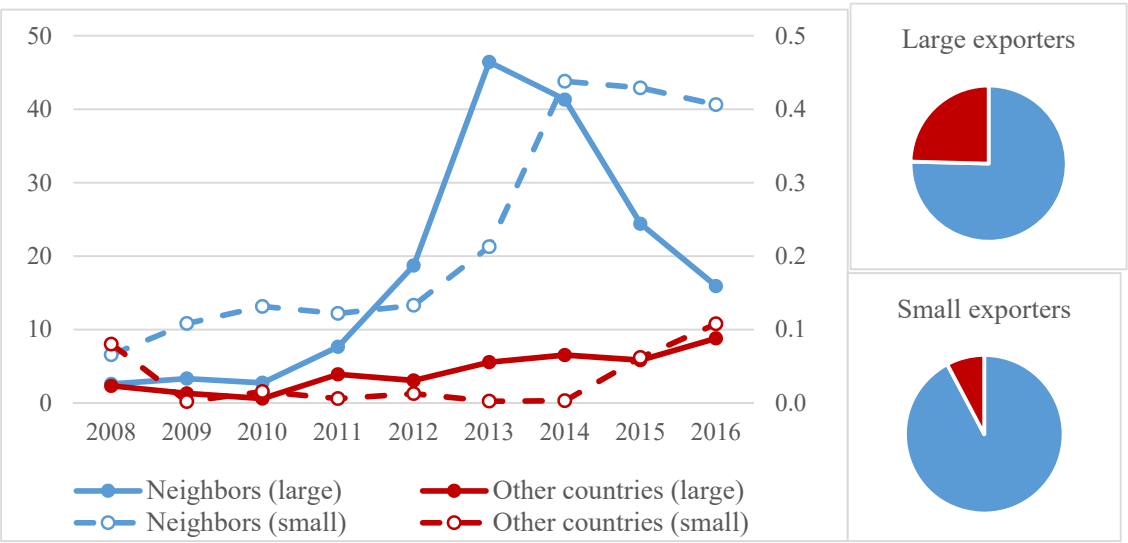
Among the four categories—two exporter size classes and two types of destinations—growth has been the fastest for large exporters to neighboring countries (the solid blue line). Those neighbors are, in order of importance as export destination, the DRC, Burundi, Uganda, and Tanzania. From 2008 to the maximum value attained in 2013, exports for this group increased 20-fold. Sales of large exporters in more distant countries (the solid red line) also

rose strongly, registering a 5-fold increase from 2008 to 2016 or even a 13-fold increase if we calculate from the base level of 2010.

However, starting in 2014, the performance of large exporters in neighboring countries deteriorated rapidly and the decline had not stopped by 2016. As mentioned, this decline in exports is predominantly the result of political and civil unrest and violence in DRC and Burundi.[10] The export volumes of larger exporters seemed particularly vulnerable to this disruption. In contrast, exports of large firms to countries further away were stable and continued to grow. As shown on the pie chart on the right, over the entire period three quarters of the exports of large firms were to neighbors. At the end of the period, this fraction stood at 64%, exactly the same as the average for 2008-2009.

Exports of small exporters to neighbors (the dashed blue line) also increased notably, expanding more than 6-fold from 2008 to its maximum level in 2014. Note that exports for smaller firms are shown on the right scale, which is 100 times smaller than the scale used for large firms on the left. The total export value of small firms exporting beyond neighboring countries is almost too small to register. In absolute volumes, it amounts to a total of 108,400 USD in 2016 which is barely higher than in 2008, but a recovery from the intervening period where they averaged only 15,000 USD (between 2009 and 2015). The large gap between the red and blue dashed lines reflects the dominance of neighbors in the exports of small firms. Over the full sample period, neighboring destinations account for 88% of small exporters foreign sales, and if 2008 is excluded even more than 90%.

Figure 8: Evolution of manufacturing exports by destination



Notes: Neighboring countries are DRC, Burundi, Uganda, and Tanzania; Small exporters are firms exporting at least 1,000 USD, but not more than 100,000 USD per year.

[10] Given that the sharp decline at the end of the sample period does not appear at all for exports to non-neighbors (the red lines) and that is much less pronounced for small exporters that would be more flexible to navigate the volatile security situation, it is unlikely to be due to incomplete reporting of data for 2015 and 2016.

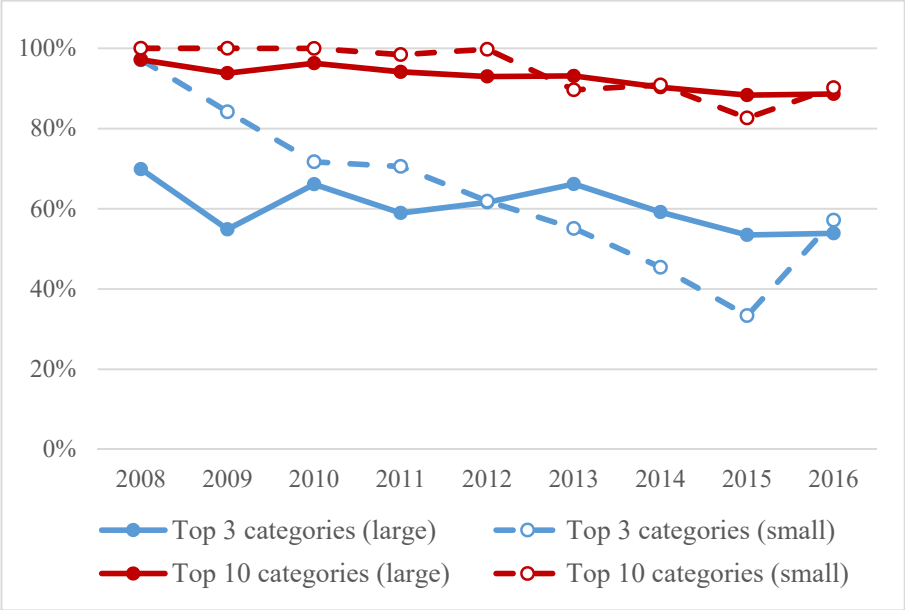
4.5 Concentration of exports by product categories

We now verify whether exports are equally concentrated by product as in terms of export destinations. Subsequently, we explore what type of products Rwandan manufacturing firms specialize in. In both cases, we continue to show separate results for small and large exporters as firm dynamics and comparative advantage could evolve differently for both types of firms.

The results in Figure 9 show the share of exports accounted for by the three (in blue) or ten (in red) most important product categories using the 2-digit Harmonized System (HS) classification. In stark contrast with the results for export destinations, we now see only a small difference for large and small exporters. In 2008, the top 10 (out of 90) product categories accounted for 98% of total exports of large firms and an even larger share for small exporters (shown, respectively by the solid and dashed red lines). Over time, this share declined monotonically, but very gradually. By 2016, the fraction was 89% for large exporters and 90% for small exporters. The only notable difference is that the fraction for small firms started its decline a bit later, as it was still over 99% in 2012, and its lowest value was also slightly lower at 83% in 2015.

The overall evolution in the share of exports accounted for by the top-3 product categories (represented by the blue lines) also looks similar for both types of firms, only the average level is lower. However, closer inspection does reveal some notable differences. For large exporters, the top-3 share was 70% in 2008 and declined to 54% by 2016. However, it already reached a low of 54% in 2009 and 59% in 2011. Ignoring the 2008 outlier, the top-3 concentration is very stable for large exporters barely showing any trend over time.

Figure 9: Evolution of product concentration in manufacturing



Note: Product categories are defined at the Harmonized System (HS) 2-digit level. Small exporters are firms exporting at least 1,000 USD, but not more than 100,000 USD per year.

In contrast, for small exporters there is a pronounced and almost continuous decline. The top-3 concentration was 97% in 2008 and this declined monotonically to 42% in 2015. The only year it increased was in 2016. This can be due to incomplete reporting, or more marginal exports, in terms of products not necessarily firms, could be more vulnerable to unrest at the border with the DRC and Burundi.

This pattern of diminishing concentration for small exporters is reinforced when we look at the type of products that show up in the top 3. Most importantly, not a single 2-digit HS product category remains in the top-3 list for the entire time period. Even the most important product categories 32 (Tanning or dying extracts) and 94 (Furniture) are missing from the top 3 in two or three years of the nine-year sample period, and in those years they sometimes do not even make the top 10. In 2013, the mineral products category 25 (Salt, sulphur, stone,…) was took first place, and the next year it was 64 (Footwear), followed by 11 (Products of the milling industry) in 2015-2016. In sum, the churn is remarkably high on the list of most popular exported products.

For large exporters the top 3 is slightly more stable. Vegetable products, Foodstuffs, Mineral, and Metal products appear most frequently, accounting for three quarters of all top-3 entries. At the same time, it is remarkable that the most important products are rather different for large and small exporters. Only in the last two years is there any overlap in the top 3, with product category 11 (Products of the milling industry) taking first place for small exporters and second place for large exporters. In no other year does a specific 2-digit category appear in the top 3 for both large and small exporters. It is even rare that they share a 2-digit product from the broader product groupings.
The composition of the top 3 for both types of firms, in terms of broad product categories, is summarized in Table 2. The first two columns show the dispersion in some detail. It counts the entries in the top 3 for all important product groupings, summed over the 9 years (i.e. the distribution of all 27 entries). Products that larger firms specialize in relatively more are shown at the top of the table and smaller firms tend to specialize in product categories shown further down in the table. For some product categories, the specialization by firm type is complete. For example, Foodstuff is the exclusive domain of large firms and Mineral products almost exclusively. In contrast, Furniture or Machinery is only exported by small firms.

In the last two columns of Table 2, we show the comparable distribution if we count in each year all product categories that are needed to capture the bulk of exports. In order to represent the same number of entries for both large and small exporters (on average 7 per year), we include all products needed to account for 90% of exports for smaller firms, but only 85% of exports of large exporters.[11]

[11] This reflects that over the full sample period, the average product concentration is higher for smaller exporters, even though it declined more rapidly over time.

Table 2: Product categories accounting for most manufacturing exports

		Top 3 categories		Categories that jointly account for most exports (85-90%)	
Broad groups	HS 2-digit	Large	Small	Large	Small
Textiles	50-63			1	
Animal products	1-5			2	
Foodstuff	16-24	4		6	
Mineral products	25-27	4	1	7	1
Footwear & raw hides, leather	41-43, 64-67	2	2	9	3
Vegetable products	6-15	8	3	12	5
Plastics & Rubber	39-40	2	4	6	7
Metal	72-83	4	2	8	10
Chemicals	28-38	3	7	7	10
Furniture & wood products	44-49, 94		6	3	11
Machinery	84-87		2	1	13
Stone & glass	68-71			1	3
No. of categories		27	27	63	63

Notes: Small exporters are firms exporting at least 1,000 USD, but not more than 100,000 USD per year. The statistics show the total number of product categories over the nine years in the sample, i.e. 3 categories in each year for a total of 27 categories in the first two columns. In the last two columns, we used a slightly lower threshold in each year to define "most exports" for large exporters (85%) than for small exporters (90%) in order to obtain the same total number of categories (63).

Even including more than twice as many products and accounting for approximately 90% of all exports, it is still the case that some broad product groupings are almost only exported by large exporters, in particular Foodstuff, Mineral products, and Footwear & leather. The almost total absence of Textiles and Animal products is also notable, given the agrarian orientation of the economy and the focus on light manufacturing. Small exporters dominate in rather different product categories, e.g. Furniture and Stone & glass, but also in Machinery, which we did not expect to see on this list. We have to keep in mind, however, that export volumes are extremely small, reaching only an aggregate of around 400,000 USD per year for small exporters. Hence, a second-hand car dealership that exported a few vehicles per year to neighboring countries would appear on this list.

Of course, specialization is not complete and there is overlap for some products. It is not unlikely that products exported by both large and small firms are exactly the type of products where Rwanda has some chance of integrating in GVCs. The most important categories where there is notable overlap for small and large exporters are Metalworking, Chemical products, and Vegetable products. With the exception of the last category, this list is not really as expected. The next categories are Plastics & rubber, Furniture, and Footwear, which are perhaps less surprising.

4.6 Firm-level characteristics of exporters

We have documented the evolution and the nature of Rwandan exports in detail. To assess the potential for further export growth, it is also important to have a sense how different current exporters are from firms that currently do not export. If they are radically different, it would be implausible that many non-exporters could enter the export market. We will also

compare small and large exporters along several dimensions to see whether differences among other dimensions than export size are important. Table 3 contains results separately for the three broad sectors. We will focus the discussion mostly on manufacturing firms, but highlight results from other sectors when they are different and interesting.

Not surprisingly, exporters are larger than non-exporters also in terms of employment, firm sales, imports. And they are also more productive. All averages in column (2) are larger than in column (1), but clearly the extent to which they differ varies a lot by row. When comparing these numbers it is important to keep the total number of observations into account, which are always indicated in brackets. This matters greatly because especially for non-exporters the average that is reported is based on a different sample of firms for different variables. In particular, employment (and therefor also sales per employee) is only reported for a small sub-set of firms, while average sales and imports are much more reflective of the universe of non-exporters. Even for those variables there is a long tail of small, informal firms that do not report any information to the government. Excluding them is not such a big problem as they are unlikely to start exporting before entering the formal sector first.[12]

Table 3: Characteristics of globally engaged versus other firms

	Non-exporters		All exporters		Exporters by 4 exhaustive groups			
	(1)		(2)		1-10	10-100	100-1000	1 mio.+
(a) Agriculture								
Employment	7	(53)	122	(26)	5	16	10	248
Firm Sales ('000 USD)	17	(1252)	1,382	(56)	117	558	336	4,711
Sales per employee	44	(42)	157	(24)	96	254	158	122
Imports ('000 USD)	2	(1261)	375	(57)	16	207	146	1,165
No. of firms per year				(41)	(9)	(11)	(9)	(13)
(b) Mining								
Employment	52	(47)	58	(18)	8		12	65
Firm Sales ('000 USD)	22	(840)	3,635	(33)	34	16	49	5,749
Sales per employee	85	(34)	667	(16)	20		45	754
Imports ('000 USD)	1	(843)	265	(34)	17	12	160	382
No. of firms per year				(25)	(3)	(1)	(3)	(18)
(c) Manufacturing								
Employment	8	(78)	99	(57)	28	58	139	174
Firm Sales ('000 USD)	55	(674)	5,264	(71)	742	1,571	2,579	17,347
Sales per employee	60	(65)	84	(56)	44	70	51	158
Imports ('000 USD)	27	(683)	3,626	(72)	323	1,613	1,983	11,485
No. of firms per year				(64)	(16)	(18)	(14)	(16)

Notes: The four exhaustive groups of exporters in the far right columns are firms exporting the indicated amounts, measured in thousands of USD per year. The numbers in brackets are the average number of firms per

[12] The number of firms reporting payroll information to the tax authorities, from which we take the employment information, is much smaller than the number of firms that report sales to the tax authority from which business income and income tax is assessed. It partly reflects sole proprietorships that do not have employees and do not report any payroll information to the tax authority). If a firm reports sales, but does not appear in the custom's data, we assign it an import level of zero and include it in the calculation of average imports per firm. This way, the number of firms is largest for the import variable by construction.

year that report that statistic. In particular, for sales per employee the average for non-exporters is not representative for all non-exporters, as very few firms report both statistics.

Even among firms that report employment, in agriculture and manufacturing the average number of employees is much larger for exporters than firms only selling domestically. The ratio of the average employment for the two groups is 20 in agriculture and 12 in manufacturing. As mentioned, this calculation conditions on firms reporting payroll information, which is not only a small fraction of all firms in the economy, it is even a small share of formally registered firms. It makes these large size difference even more remarkable.

Given that firm sales is reporting much more broadly, we expect the difference between exporters and non-exporters to be even larger. In an average year, 57 exporters report employment and 71 report sales, which is one quarter higher. In contrast, from the very large sample of non-exporters only 78 report employment, but 674 report sales, a more than 8-fold boost. Average firm sales is almost 100 times higher for exporters than for non-exporters and this ratio is likely to reflect better the comparison for the universe of formal firms than the employment comparison.

The ratios are even further apart for the average value of imports. The average exporter in the manufacturing sector imports 134 times as much as the average non-exporter. The greater discrepancy is partly due to the inclusion of many zero-import flows, but that is likely to accurately reflecting reality. In agriculture, exporters even import 250 times as much.

While these comparisons suggest that exporters operate very differently from non-exporters, it is worthwhile to point out that the average imports as a fraction of sales are not that different. In manufacturing this ratio stands at 69% for exporters and 49% for non-exporters. In agriculture, this ratio is lower, as expected. The difference between exporters and non-exporters are larger here, at 27% versus 9%, but much smaller than the absolute difference in import activity.

The differences between exporters and non-exporters are also much reduced when we look at sales per employee, a crude measure of labor productivity. This can only be calculated on the subset of firms reporting both variables, a small subset of the group of non-exporters. The strong correlation between differences in sales and employment makes that the ratio differs much less than for either variable on its own. The productivity premium for the average manufacturing firm is positive, but only 40%. The productivity ratios for the average agricultural firm is 3.5, which implies a productivity premium of exporters of 250%.

We report all statistics also for mining firms, but the very high average employment for non-exporters is not very reliable. The average non-exporting mining firm reports to employ 52 employees, almost the same as exporters, even though their annual sales are less than 1% of the annual sales of exporters. It is hard to imagine what non-exporting mining firms in Rwanda actually do, hence we do not focus on the exporter vs. non-exporter comparison in mining.

In the four rightmost columns of Table 3, we compare the same variables across exporters with different export exposure. Reporting of the different variables is much more consistent within the group of exporters, comparing performance differences is a lot more straightforward now.

For manufacturing firms, employment and firm sales gradually increase over the four categories of export engagement. The differences are relatively small, given that average exports increase more than 200-fold from the '1-10' column to the '1 mio+' column (these labels respectively indicate 'annual exports between 1,000 and 10,000 USD' and 'exports above 1 million USD'). Employment increases 6-fold and sales 18-fold over the different columns, which is a lot less than the export increase.

Given that sales increases more rapidly than employment across the export categories, it implies that sales per worker also grows with firms' export engagement. It is 3.5 times larger for the top exporters versus the smallest exporters, but it is even 3 times larger compared to the second-smaller category of firms exporting already a respectable 10,000 to 100,000 USD. The absolute level of sales per worker is remarkably high for a relatively poor country. The largest exporters have sales of 158,000 USD per employee, but even for marginal exporters an average sales of 45,000 USD per employee can be considered high in a country with a GDP per capita below 1,000 USD.

The pattern is somewhat different across agricultural or mining exporters. In agriculture, higher sales for the largest exporters go hand in hand with a (more than) proportional increase in employment. As a result, there is no clear pattern in terms of sales per employee, or labor productivity, by the extent of export engagement. In mining, the top exporters are in an entirely different league from the other firms. But given the very small number of exporters in the first three categories, the comparison is not that informative here.

Finally, it is interesting to comparing the first category of marginal exporters (i.e. firms exporting between 1,000 and 10,000 USD per year) with non-exporters that are registered and report employment. In manufacturing, exporters employ approximately 3 times as many workers, but they have on average slightly lower labor productivity. Note, however, that differences are larger for average sales. Hence, we are really comparing marginal exporters with the small subset of non-exporters that formally employ workers. For agriculture, marginal exporters only show an advantage in labor productivity, not employment. Based on the few firm characteristics we observe, there are no large difference between (the most formal) non-exporters and marginal exporters. It suggests that better market access abroad could gradually draw additional firms into the export market.

4.7 Export market entry

The final piece of analysis consists of a set of regressions that model the likelihood a firm is active on the export market. In Table 4 we report coefficient estimates for a linear probability model, but we have also estimated the model with a Probit regression.[13] The different specifications reported in each column gradually relax the functional form restrictions on the way sales and labor productivity enter as control variables. Given that variables are often missing, we always include two variables for both of these firm

[13] The signs of the coefficients on the different variables are always the same for both specifications. We report the linear probability results as it is more straightforward to interpret the parameters. The probability of exporting is sufficiently low that the predicted probability never exceeds unity when we look at larger firms (firm size is the explanatory variable we focus on most).

Table 4: Predicting export market participation

	Dependent variable is dummy for export market participation					
	(1)	(2)	(3)	(4)	(5)	(6)
Mining	0.007***	0.005**	0.005**	0.002	0.052*	0.007***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.03)	(0.00)
Manufacturing	0.007***	0.005**	0.002	-0.003	-0.026	0.014***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)
Age (in dataset)	0.012***	0.005***	0.007***	0.005***	0.005***	0.007***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Kigali	-0.068***	-0.004	-0.034***	-0.025***	-0.024***	-0.032***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Other Tax Centre	-0.060***	0.014***	-0.029***	-0.013***	-0.010***	-0.025***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Sales missing (or zero)	-0.060***	0.139***	-0.013***	0.003	0.009***	-0.005**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Sales (million USD)	0.046***					
	(0.00)					
$(\text{Sales})^2$	-0.000***					
	(0.00)					
Log (Sales + 0.001)		0.072***				
		(0.00)				
$\text{Sales}^{0.5}$			0.207***	0.168***		
			(0.00)	(0.00)		
Manuf * $\sqrt{\text{Sales}}$					0.149***	0.181***
					(0.00)	(0.00)
Mining * $\sqrt{\text{Sales}}$					0.200***	0.242***
					(0.01)	(0.00)
Agric * $\sqrt{\text{Sales}}$					0.244***	0.285***
					(0.01)	(0.01)
Missing Labor Productivty				-0.201***		
				(0.01)		
Manuf * (Missing log(LP))					-0.134***	
					(0.01)	
Mining * (Missing log(LP))					-0.213***	
					(0.02)	
Agric * (Missing log(LP))					-0.166***	
					(0.02)	
Log(LP) (zero for missing)				0.018***		
				(0.00)		
Manuf * log(LP)					-0.002	
					(0.00)	
Mining * log(LP)					0.027***	
					(0.00)	
Agric * log(LP)					0.012***	
					(0.00)	
Time	-0.009***	-0.003***	-0.004***	-0.002***	-0.002***	-0.004***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
R-squared	0.244	0.307	0.330	0.351	0.361	0.340
N	26,340	26,340	26,340	26,340	26,340	26,340

Notes: Linear probability model estimated with OLS. Significance at the 10%, 5%, and 1% levels are indicated by *, **, and ***.

characteristics: (1) a dummy in case the variable is missing, and (2) the continuous control variable where missing values are replaced by zero. That way we can estimate the effect on these incompletely reported variables without restricting the sample.

Mining and manufacturing firms are more likely to export in most specifications, but the difference with agricultural firms, the outside category, is not large. Firms that have been observed for more years—an imperfect proxy for age—are also more likely to export. Against expectation, firms located in the capital Kigali, Rwanda's most important economic center, are less likely to export. Once we control for firm age and time-varying sales, the estimated time trend is negative even though we know that unconditionally the fraction of firms that export grows over time.

In columns (1) to (3) we experimented with different functional forms of how to control for sales. The R-squared suggests that we attain the best fit using a single variable, the square root of sales. Firms with higher total sales are more likely to enter the export market, but this effect diminishes with size. The concavity with size is less strong that implied by log-sales. It is quite remarkable that overall we obtain an R-squared of 0.33 using only a very limited set of observables. In column (6) we allow the impact of sales to vary by sector and we find that small firms are least deterred from exporting in manufacturing and most in agriculture.

In columns (4) and (5) we additionally control for labor productivity. Firms for which we do not observe labor productivity, i.e. firms which do not report any payroll information, are less likely to export. The coefficient of -0.2 indicates a huge effect. Informal firms are a lot less likely to appear in the custom's database as well. Among firms reporting labor productivity, we find a positive correlation between productivity and the likelihood of exporting. This is in line with the predictions of the Melitz (2003) model. However, the results in column (5) that allow for heterogeneous effects by sector indicate that there is no relationship between labor productivity and export propensity for manufacturing firms. Moreover, informal firms in manufacturing are less likely to export, but this effect is much smaller than in the agriculture and especially in the mining sector.

In Table 5 we adopt the same specification as in column (6) of Table 4, but we show results for several dependent variables that measure different dimensions of integration in GVCs. At the bottom of the table we report the average for the dependent variable such that the relative magnitudes of the coefficients in different columns can be put in context. Given that sectors differ in their integration with the world economy, we show results separately for the three broad sectors.

In column (1), we replicated the results from Table 4 that uses a dummy for any exports as dependent variable as benchmark. When we only put the dependent variable to one when exports leave the immediate region, results reported in column (2), the positive effect of higher sales almost halves for manufacturing firms. The decline of the coefficient on (the square root of) sales is even larger than the decline in the unconditional export propensity. It indicates that the advantage for large manufacturing firms to enter more distant export markets is diminished, which is definitely an unexpected result. The advantage of age also declines, but so does the disadvantage of locating in the capital. In the mining and agricultural sectors, the coefficient on sales is virtually unchanged, which means that the relative impact of sales is strengthened given the decline in the unconditional export propensity.

Table 5: Predicting various dimensions of GVC integration

Dependent variable is a dummy for:	Any exports	Exports beyond Neighbors	Exports beyond sub-Saharan Africa	Any import	Export & Import
(a) Agriculture	(1a)	(2a)	(3a)	(4a)	(5a)
Sales missing or zero	0.019***	0.022***	0.011***	-0.022***	0.030***
	(0.003)	(0.003)	(0.002)	(0.005)	(0.002)
$Sales^{0.5}$	0.306***	0.267***	0.183***	0.332***	0.280***
	(0.005)	(0.004)	(0.004)	(0.009)	(0.004)
Age (years in dataset)	0.002**	0.002**	0.002***	0.006***	0.001**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Kigali	0.007	-0.005	-0.005	0.034***	0.005
	(0.006)	(0.005)	(0.005)	(0.011)	(0.004)
Other Tax Centre	-0.006	-0.006	-0.011***	-0.030***	0.005
	(0.005)	(0.004)	(0.004)	(0.008)	(0.003)
Time	-0.003***	-0.004***	-0.004***	-0.010***	-0.002***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
R-squared	0.28	0.29	0.19	0.16	0.37
Number of observations	11771	11771	11771	11771	11771
(b) Mining	(1b)	(2b)	(3b)	(4b)	(5b)
Sales missing or zero	-0.008*	-0.001	0.000	-0.025***	0.012***
	(0.004)	(0.004)	(0.004)	(0.006)	(0.003)
$Sales^{0.5}$	0.239***	0.240***	0.239***	0.166***	0.162***
	(0.004)	(0.004)	(0.004)	(0.005)	(0.003)
Age (years in dataset)	0.009***	0.007***	0.007***	0.017***	0.008***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
Kigali	-0.034**	-0.028**	-0.027**	-0.012	-0.025**
	(0.015)	(0.014)	(0.014)	(0.021)	(0.011)
Other Tax Centre	-0.023***	-0.016***	-0.015***	-0.019***	-0.006
	(0.006)	(0.006)	(0.006)	(0.008)	(0.006)
Time	-0.006***	-0.005***	-0.006***	-0.019***	-0.009***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
R-squared	0.39	0.42	0.43	0.18	0.34
Number of observations	7864	7864	7864	7864	7864
(c) Manufacturing	(1c)	(2c)	(3c)	(4c)	(5c)
Sales missing or zero	-0.038***	-0.004	0.001	-0.189***	-0.024***
	(0.006)	(0.004)	(0.003)	(0.009)	(0.005)
$Sales^{0.5}$	0.170***	0.091***	0.058***	0.177***	0.171***
	(0.004)	(0.002)	(0.002)	(0.006)	(0.003)
Age (years in dataset)	0.011***	0.002**	-0.001*	0.026***	0.012***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
Kigali	-0.070***	-0.023***	-0.005	-0.178***	-0.059***
	(0.007)	(0.005)	(0.004)	(0.013)	(0.007)
Other Tax Centre	-0.055***	-0.015***	-0.003	-0.250***	-0.043***
	(0.008)	(0.006)	(0.004)	(0.014)	(0.007)
Time	-0.005***	-0.002*	0.001	-0.036***	-0.006***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
R-squared	0.36	0.21	0.15	0.32	0.39
Number of observations	6709	6709	6709	6709	6709
Mean of the dep. variable	0.032	0.020	0.015	0.085	0.023

Note: All regressions include firm FE and a control for firm size. Robust standard errors in parentheses. Significance at the 10%, 5%, and 1% levels are indicated by *, **, and ***, respectively.

The results continue to change in the same direction in column (3) for exports beyond the sub-Saharan African region. While larger manufacturing firms are still more likely to export outside the region than smaller firms, the effect of sales is lower than the estimated effect including nearby exports. For faraway exports the coefficient on sales also declines for agricultural exporters. The lower export propensity for firms located in Kigali is disappears completely for faraway exports, which is not implausible. The probability to realize distant exports has declined less over the sample period than for regional exports.

In the last two columns we also look at the importing dimension. If we estimated the model pooling all sectors, the greater proclivity of manufacturing firms to engage in importing was very pronounced. The estimates for manufacturing and agriculture also indicate that the size advantage is much larger for importing than for exporting, which is consistent with evidence for the United States in Bernard et al. (2009). Note that this size premium refers to direct importing, while smaller importers are likely to simply rely on wholesalers and use indirectly imported intermediates. The higher coefficient on age can be understood in the same way.

5. Conclusions

Based on the results reported above, we were able to distill the following eight takeaway messages. We have organized them in the order that we discussed the underlying evidence:

Message 1: Remarkably few firms in Rwanda are globally engaged. Even though the number of exporters increased over the last decade, especially among manufacturing firms, the total number of exporters remains extremely very low.

Message 2: International trade has increased a lot in volume from 2008 to 2015, especially for manufacturing firms. The growth rate has been most rapid and least volatile for manufacturing, which gradually and continuously increased its share of aggregate exports.

Message 3: Only for exports of manufacturing products is it relevant to look beyond the largest exporters. For agriculture or mining exports, firms exporting less than 100,000 USD per year—which already is a high threshold—barely matter, at least when we confine ourselves to officially recorded trade transactions.

Message 4: International trade in manufacturing products is extremely concentrated by trading destination and goes almost exclusively to a few neighboring countries. This concentration has not declined over time. Mining and agriculture trade is almost equally concentrated, but those products are exported to much farther destinations.

Message 5: Manufacturing exports are highly concentrated in a few product categories, but this concentration is slowly decreasing over time, especially for smaller exporters.

Message 6: The concentration of large and small manufacturing exporters in terms of 2-digit product categories overlaps remarkably little. We do, however, see some convergence over time.

Message 7: Manufacturing exporters are larger than non-exporters, but of similar productivity than non-exporters that are formally registered. Only the largest exporters (firms that export more than 1 million USD per year) are much better on all dimensions. Differences between

small and medium-sized exporters and even between small exporters and non-exporters are much smaller.

Message 8: Participation of individual firms in international trade can be rather well predicted by a very limited set of observables. The square-root of firm-level sales is a particularly strong good predictor, as is dummy variable for formal registration and the reporting of payroll information to the authorities. The level of labor productivity only predicts participation in international trade outside of manufacturing (positively).

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