Final report RWA-24056 December 2025

The fruits of globalization

Connecting Rwandan horticultural farmers to export value chains

Shilpa Aggarwal
Jonathan Robinson
Youngwoo Song
Alan Spearot

DIRECTED BY

FUNDED BY

The Fruits of Globalization: Connecting Rwandan Horticultural Farmers to Export Value Chains*

IGC Final Report

Shilpa Aggarwal Jonathan Robinson Youngwoo Song
Alan Spearot

December 19, 2025

1 Introduction

Export markets pay a premium over local markets for (verifiably) high-quality agricultural products, and an extensive literature documents that exporting firms are larger, more successful and better managed than non-exporting firms (i.e. Bernard et al. 2007, Bloom et al. 2021). As developing countries expand agricultural productivity beyond domestic subsistence requirements, governments often promote agricultural export for both, as a method to expand economic production, as well as to increase profits and profitability for agricultural producers. However, it is unclear how on-the-ground constraints in developing countries hinder efforts to grow through exports, especially in agriculture.

This project takes place in Rwanda, where the National Agricultural Export Development Board (NAEB) is tasked with expanding export production as part of Rwanda's national strategic plan (NAEB 2019). NAEB has successfully increased exports in specific value chains, including avocados, french beans and chili peppers.[1] The Rwanda government has put

*Aggarwal: Indian School of Business, Hyderabad, India, ; Robinson: UC Santa Cruz, jmrtwo@ucsc.edu; Song: UC Santa Cruz, ysong96@ucsc.edu; Spearot: UC Santa Cruz, aspearot@ucsc.edu. We thank Innovations for Poverty Action for data collection.

[1]For example, chili pepper exports have expanded from 650 metric tonnes in 2018/19 to 2,000 tonnes in 2024/25, while avocadoes expanded from 1,000 to over 4,000 tonnes in the same time period (IGIHE 2025).

substantial resources into expanding the horticultural sector, including major institutional investments such as an avocado packaging facility near the Kigali airport, dedicated fresh cargo flights to Europe, and recently, a pilot for bulk-shipping via ocean freight.

However, the form of support that is most relevant to this research is that the government has distributed saplings or seeds to farmers, often packaged with the dissemination of recommended agronomic practices. By providing farmers with start-up capital to initiate production, the government hopes to catalyze producers to produce and sell high-quality produce in value chains, either those that culminate in exports or those that lead to sales to domestic processors and supermarkets, both of which are believed to be highly profitable. In our data, we find that 70% of avocado producers received the original samplings for their trees either directly from the government (i.e. NAEB) or from an NGO (likely in a program sponsored by the government as well). Have these investments led to profits for beneficiary producers?

An implicit assumption behind all these efforts is that selling into value chains will increase profits, but while it is well-known that revenues in value-chains are higher, so are the quality standards and therefore, costs, and so it remains unclear whether increasing sales into value chains will necessarily increase farm profits. In this pilot project, we descriptively document the profitability of horticulture producers in Rwanda, and explore how performance varies between those which participate in the export market compared to those which sell only domestically (either in value chains or solely to local markets directly). While none of these producers export directly, 43% sell to firms that export themselves.

Producers that sell only locally have low revenue (only about \$380 per year), and we actually estimate that average profits are negative (about -\$200). We find that those which sell into value chains (i.e. to supermarkets or domestic processors) earn significantly more revenue (about \$900 per year). Revenue is much higher ($\sim$ \$3000) for those that sell to exporters. Unsurprisingly (since they are larger), we also find that contemporaneous input costs are also higher for these firms. However, what is surprising is that higher input costs largely cancel out revenues: we estimate that profits for those selling to domestic value chains are actually highly negative (∼ -\$1,000), while profits for those selling to exporters, while positive, are only about \$500. Although we conjecture that this could be due to measurement error, or under-reporting of revenue (i.e. larger firms more accurately report costs than revenues, similar to an issue in household surveys where expenditures are better measured than income), we take this as at least suggestive evidence that profits for farmers cultivating for export markets are currently modest. While we have data from only a single year, it is also of note that these profit calculations do not account for the sizeable startup costs involved in procuring saplings (which, as described above, was largely subsidized by the government) and nurturing them to the stage at which they yield fruit. Accounting for those substantial costs would make profits even lower.

What then is preventing firms from being more successful? We asked farms about the challenges they face, and while a number of challenges emerged, the most common reported challenge is disease: almost all producers report disease in the prior year, and reported losses are extremely large: almost 2/3 of producers reported that yields were half or less than half as large as they would have been without disease, and this was equally a problem for both farmers selling for export, and those selling domestically. Interestingly, farms selling for export were twice as likely to engage on major remediation efforts, such as uprooting diseased plants, but otherwise adopted similar practices for disease management.

This project is related to a growing literature about the benefits of being connected to international value chains (Boudreau et al. 2023), such as learning-by-exporting, whereby firms learn how to improve quality and productivity via experience with selling to higher-value customers (Atkin et al. 2017). Other studies find that exporting leads to greater technical efficiency, typically through complementarity with investment (Garcia-Marin and Voigtländer 2019), and that selling to richer buyers is robustly associated with quality upgrading (Verhoogen 2023). Our study is also related to recent papers on the factors that constrain farmers and exporters from coming together. There is an emerging literature on practices adopted by exporting firms while selling, such as Antras and Foley (2015) on financing, Cajal-Grossi (2022) on search and contracting, and Ksoll et al. (2023) on risk mitigation. Our work suggests that disease management is a key constraint in this sector.

Our results also contribute to a literature on the effects of export promotion strategies, especially in developing economies. Our results, while still very preliminary, suggest that efforts to expand exports in horticulture in Rwanda may be modest without more robust investments into disease-resistant varieties, or in other disease control efforts. Programs to improve the ability of producers to recognize and manage disease may also be effective.

2 Data and Sampling

We systematically document the revenue, costs, and profits of a representative (though small sample) cross-section of producers, and compare the experience of exporters and local sellers. We started with 1844 horticultural producers, but could not contact 858 because of either incorrect or missing contact information. From the remaining 986, we sampled 132 for detailed interviews regarding farm revenues, costs, crop disease, challenges, and other information, over the 12 months preceding the survey.

Summary statistics on these producers are presented in Table 1. Panel A shows crop types (though these categories are not exclusive). Although we originally set out to focus on passion fruit, as can be seen there are not many passion fruit producers and thus only 11% of the sample grows that crop. Sixty-one percent grow avocado, 27% french beans, and 36% chili pepper. From Panel B, we see that 1/3 have a contract, and 18% are cooperatives (the rest are privately run).

Panel C shows some information on harvest, sales, and revenue. The average producer harvest about 3,000 kg of output, and sells almost all of this. Revenue averages about $1560 USD, though input costs are nearly as large as revenue, and thus profits on average are close to zero. However, from Column 2, we can see that the standard deviation for all these variables is huge, implying that some firms are very large, a point to which we return to later. However, the basic picture of modest profitability is one of our main findings.

Finally, Panel D presents evidence on the source of planting materials (we only collected this information from avocado producers). We find that a total of 70% received the saplings either from a government agency or NGO, while 13% received them as part of a contract, 16% bought them from an agrodealer, and a smaller percentage produced them themselves (9%), or received them from a friend or neighbor (7%).

Table 1: Summary Statistics

	(1) Mean	(2) SD
Panel A: Crops grown by producers		
Passion fruit	0.11	
Avocadoes	0.61	
French beans	0.27	
Chili / Pepper	0.36	
Panel B: Proportion of producers by firm type		
Exporters	0.43	
Domestic value chains	0.11	
Local market	0.45	
Panel C: Producer type		
Has a prior contract	0.33	
Cooperative	0.18	
Panel D: Production and sales		
Total Harvest (kg)	3012	9698
Total Sale (kg)	2933	9685
Total Revenue (USD)	1563	5064
Total Input Cost (USD)	1526	3217
Total Profit (USD)	37	2885
Panel E: Source of saplings (avocado only)		
Government agency or NGO	0.70	
Bought from agro dealer	0.16	
Received as part of contract	0.13	
Produced themselves	0.09	
Neighbor / friend	0.07	

Notes: There are a total of 114 producers in the sample. However, since panel E is only for avocados, the number of observations in this panel is 70.

3 How do exporters compare?

For the remainder of this report, we describe differences between firms that sell for export markets, and other firms. Specifically, we focus on 3 types of firms: (1) those that sell for export; (2) those that sell into domestic value chains (i.e. where output is ultimately either processed domestically or sold to domestic retailers such as supermarkets); and (3) those that sell only in local markets.

We first show how reported quality standards vary in Table 2. As expected, we find that exporters face higher quality standards: they report that 71% of buyers test for quality in some form, and 28% of them have had produce rejected. Even for domestic value chains, these percentages are much lower: just 35% have standards, and 12% have had produce rejected. Interestingly, only a somewhat smaller share report quality standards for local buyers (27%).

Table 2: Quality standards and rejection

	(1) Exporters	(2) Domestic Value Chain	(3) Local Market
Has quality standards	0.71	0.35	0.27
Has had produce rejected	0.28	0.12	0.14

Notes: N = 114.

Having established that quality standards appear to be higher in export markets, we present summary statistics on producer revenues, costs and profits in Table 3, where we see a clear ranking of revenues (and costs): exporters are largest, producers selling to domestic value chains are second, and producers selling only locally are the smallest. Revenues are about $3,000 USD for exporters, but only $910 for those selling to domestic value chains, and only $380 for producers selling locally. Input costs (which include all variable costs, including agricultural inputs and labor) follow a similar pattern: costs are over $2,400 for exporters, $1,930 for those selling to domestic value chains, and $585 for those selling locally.

Simple contemporaneous profits, therefore, are simply the difference of these two, and are low but positive for exporters (only about $570 per year). For firms selling to domestic value chains, profits are actually highly negative, at about -$1,000 per year), and still negative but less so for those selling locally (about -$200). On average, then, at least in this small sample, we observe evidence that all of these producers are not very successful. While exporters earn more revenues and somewhat higher profits, the level of profits remain quite modest.

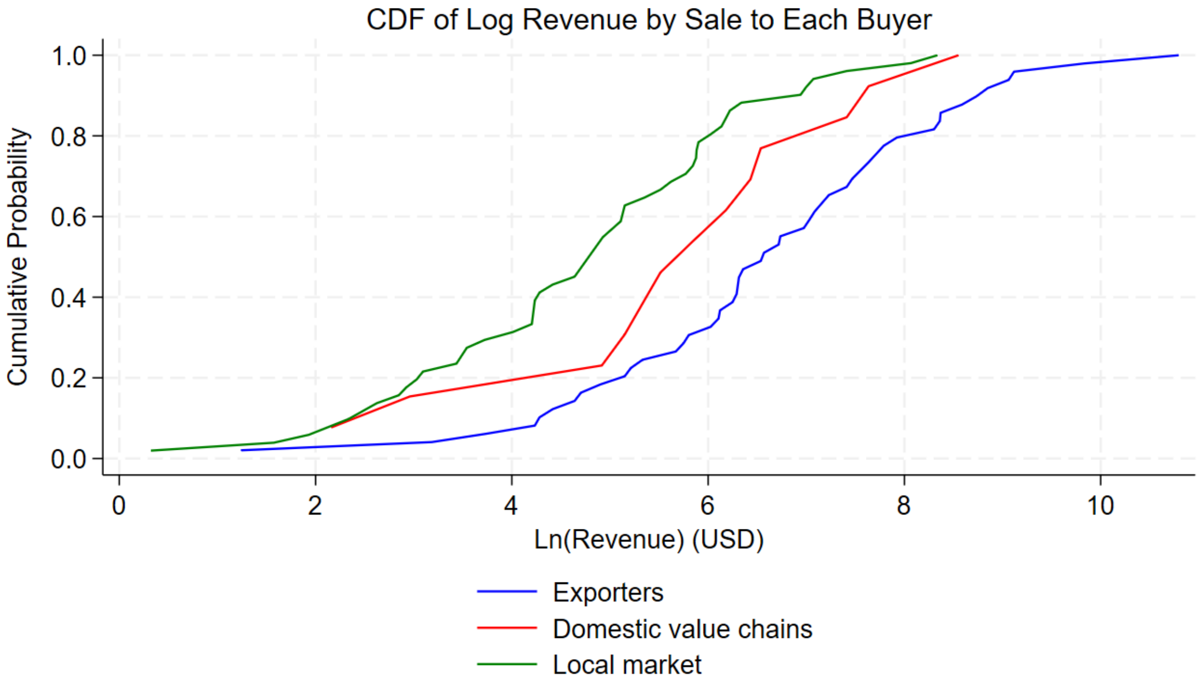
Table 3: Sales, costs and revenues

	Revenue		Input Cost		Profit	
Selling to...	Mean	SD	Mean	SD	Mean	SD
Exporters	2998	7450	2427	4220	571	4123
Domestic value chains	910	1426	1935	3625	-1025	2337
Local market	382	759	585	1165	-203	743

Notes: N = 114. Material costs include all variable costs, including agricultural inputs and labor costs. Profits are simple contemporaneous profits, i.e. revenue-cost, and do not account for amortized fixed costs.

While revenue and profits are, on average, very low, a minority of producers are more successful. We explore that heterogeneity in CDFs in Figure 1 (for log revenue) and Figure 2 (for the inverse hyperbolic sine of profits, which we use because profits take on negative values). From Figure 1, we see clear evidence that the distribution of revenue follows the pattern above, with exporters earning the most and those selling locally the least, throughout the distribution.

Figure 1: Log revenue

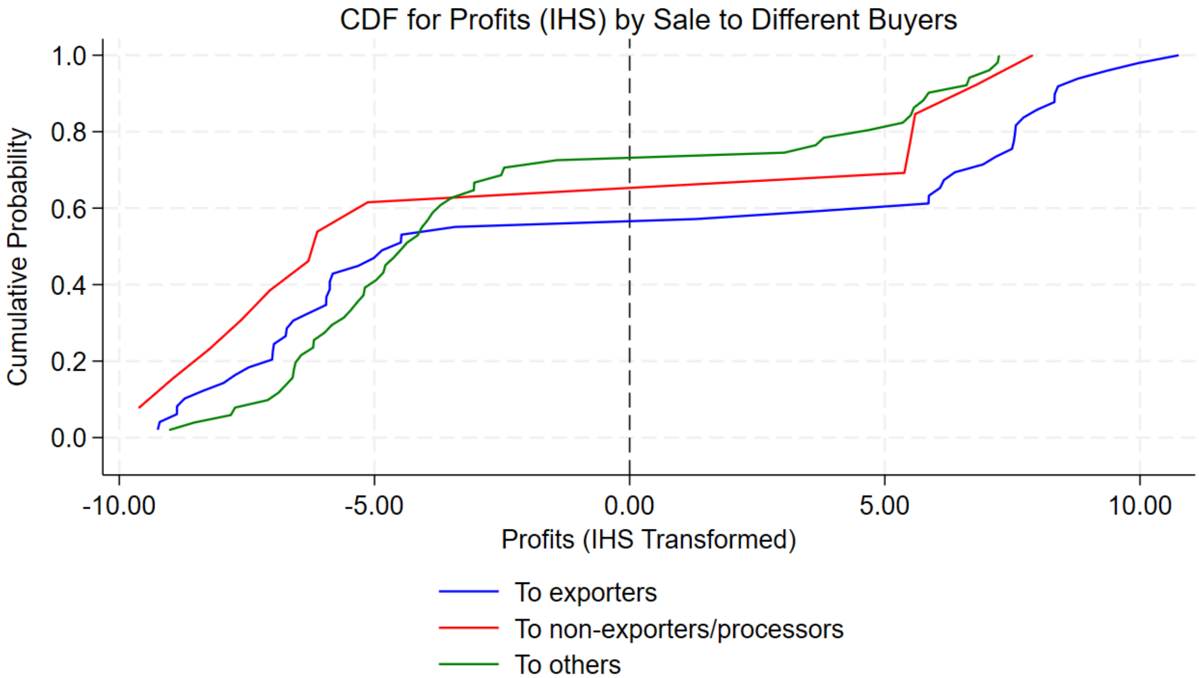


Turning to profits, the picture is somewhat less clear.[2] In Figure 2, we include a dashed zero profit line, and we see that substantial numbers of producers report negative profits. While about 70% of producers which sell locally earn negative profits, this is still 60% for those selling to domestic value chains, and 50% for those which are selling for export.

On the other hand, we do see that a minority of firms are very successful, earning high profits. Future work, with a larger sample, might explore those factors which might explain why some firms are successful and others not.

[2]See Figure A1 for the CDF of raw profits, and Figure A2 for a more readable CDF where profits are truncated between -$1,500 and $1,500.

Figure 2: Profits (Inverse Hyperbolic Sine)



We formally test for differences in Table 4 where we also control for fixed effects for the main crop that the producer grows (since this is a main source of heterogeneity). In regression form, results confirm large, statistically significant differences in revenues and input costs for exporters. The coefficient on profits is positive but fairly small (only \$570) and not statistically significant. Producers selling into domestic value chains also have higher revenue and costs than those selling locally, but differences are smaller and not significant. Surprisingly, profits for those selling into domestic value chains are actually lower than those selling locally, though this coefficient is not significant - we conjecture that this is possibly due to measurement error, and do not wish to make too much of it here. Nevertheless, this table is consistent with the basic set of results, which is that these firms on the whole are not very successful on average.

Table 4: Differences in revenues, costs and profits by type of firm

	(1) Revenue	(2) Total Input Cost	(3) Profit
Exporter	3973.13***	3404.71***	568.42
	(1304.07)	(795.64)	(763.88)
Non-exporting firm or processors	401.13	1199.07	-797.94
	(1588.04)	(968.90)	(930.22)
N	113	113	113

Regressions control for crop fixed effects. Standard errors in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

4 What explains poor performance?

In our surveys, we asked producers to list the main challenges that they face to increase production of high quality produce. Although producers list a number of challenges, the most striking is disease. Ninety percent of exporters report disease as a challenge; interestingly, this is substantially higher than the percent of those selling into domestic value chains (69%) or to the local market (61%), despite the fact that quality is presumably higher for exporters. We interpret this as that the higher quality standards that they face make quality a much bigger issue. However, we also note that producers report a number of other challenges: about 20-30% report that credit and lack of quality certification services are important constraints.Interestingly, among non-exporters, much higher percentages (about 30-50%) report lack of information on buyer expectations or lack of connections to find buyers, consistent with the prior literature about matching frictions.

Table 5: Self-reported challenges

	Exporters	Domestic value chains	Local market
Disease	0.90	0.69	0.61
Lack of credit	0.20	0.31	0.26
Lack of certification services	0.20	0.31	0.26
Lack of info on buyer expectation	0.12	0.46	0.31
Lack of connections to find buyers	0.12	0.39	0.43
Lack of access to planting materials	0.06	0.39	0.26
Observations	49	13	51

Note: Table shows mean proportions of farmers reporting each challenge by sales destination.

We dig into the issue of disease specifically in Table 6, where we document disease prevalence for the various groups. First, we find extremely high levels of disease: 94% of exporters, 100% of those selling to domestic value chains, and 75% of those selling local report disease in the past year. In Panel B, we report information on the reported yield loss from disease. Among exporters, 76% report that yields were at most half as large as they would have been without disease. Interestingly, among those producing for domestic value chains or locally, estimated losses are somewhat lower, though still very large on an absolute basis.

Table 6: Crop diseases and yield reduction

	Exporters	Domestic value chains	Local market
Any disease	0.938	1.000	0.745
Panel A: Crop diseases faced by producers			
Fruit rot disease	0.86	0.77	0.55
Leaf spot disease	0.43	0.69	0.35
Root rot disease	0.29	0.15	0.12
Woodiness	0.22	0.39	0.29
Blight	0.20	0.31	0.20
Fruit flies	0.10	0.23	0.06
Panel B: Yield Reduction from disease			
Crop completely destroyed	0.02	0.08	–
Yields were less than half	0.57	0.46	0.61
Yields were about half	0.17	0.08	0.05
Yields were more than half	0.24	0.39	0.34
Observations	49	13	51

Note: The table shows the proportion of sample that faces each disease by firm type.

5 Discussion and future research

The government of Rwanda has put substantial resources into developing the horticultural export sector, including the distribution of planting materials at heavily subsidized prices. Has this investment been effective?

In this descriptive work, we measure revenues, costs, and profits for firms that export and others that sell into domestic value chains, and compare these to firms that sell only in local markets (where, presumably, quality standards are much lower). We find that exporting firms have much higher revenues, but costs are also higher, and we find that contemporaneous profits for these firms are modest (only about $500 per year), which would imply these firms do not even realistically provide income to survive upon. While our surveys were only preliminary, and we do not want to make too much of the specific dollar amounts we estimate, we are confident in saying that profits are fairly modest.

Why do firms struggle? In self-reports, firms list a variety of challenges, but one that stands out is disease incidence. Though only descriptive, the majority of producers report substantial yield losses from disease. In surveys, we asked about strategies producers take to mitigate disease (see Table 7), and while the use of pesticides is nearly universal, other strategies are much less common. Exporters are twice as likely to uproot infected plants, but otherwise their strategies are very similar to non-exporting firms.

Table 7: Disease mitigation strategies

Prevention measure	Exporters	Others
Don't do anything	0.000	0.047
Plant certified plantings	0.082	0.172
Maintain adequate distance between plants	0.102	0.188
Apply fungicide/pesticide	0.939	0.859
Crop rotation and fallowing	0.204	0.172
Uproot/treat symptomatic plants	0.388	0.188
Observations	49	64

Given these results, there are several possible interventions that may be useful to explore, including:

- Developing a system of certifying producers to multiple disease-reistant varieties, similar to a system for cassava that the PI team is currently evaluating among coopreatives
- Better disease monitoring and early warning systems
- Training farmers in integrated pest management techniques

In the coming months, we hope to share these results with NAEB and examine the possibility of collaborating on some of these ideas.

References

Antras, Pol and C Fritz Foley (2015). "Poultry in motion: a study of international trade finance practices." *Journal of Political Economy* 123 (4): 853–901.

Atkin, David, Amit K Khandelwal, and Adam Osman (2017). "Exporting and firm performance: Evidence from a randomized experiment." *The quarterly journal of economics* 132 (2): 551–615.

Bernard, Andrew B, J Bradford Jensen, Stephen J Redding, and Peter K Schott (2007). "Firms in international trade." *Journal of Economic Perspectives* 21 (3): 105–130.

Bloom, Nicholas, Kalina Manova, John Van Reenen, Stephen Teng Sun, and Zhihong Yu (2021). "Trade and management." *Review of Economics and Statistics* 103 (3): 443–460.

Boudreau, Laura, Julia Cajal-Grossi, and Rocco Macchiavello (2023). "Global value chains in developing countries: a relational perspective from coffee and garments." *Journal of Economic Perspectives* 37 (3): 59–86.

Cajal-Grossi, Julia (2022). "Searching for trade partners in developing countries." *Geneva Graduate Institute, Mimeo.*

Garcia-Marin, Alvaro and Nico Voigtländer (2019). "Exporting and plant-level efficiency gains: It's in the measure." *Journal of Political Economy* 127 (4): 1777–1825.

IGIHE (2025). *"Avocado exports reach 4,200 tonnes as Rwanda earns Frw 125 billion from horticulture"*. URL: https://en.igihe.com/business-62/article/avocado-exports-reach-4-200-tonnes-as-rwanda-earns-frw-125-billion-from.

Ksoll, Christopher, Rocco Macchiavello, and Ameet Morjaria (2023). "Electoral violence and supply chain disruptions in Kenya's floriculture industry." *Review of economics and statistics* 105 (6): 1335–1351.

NAEB (2019). *National Agricultural Export Development Board Strategic Plan 2019-2024*. URL: https://naeb.gov.rw/fileadmin/documents/191126%%2020NAEB%20Strategy%202019-2024_FINAL.pdf.

Verhoogen, Eric (2023). "Firm-level upgrading in developing countries." *Journal of Economic Literature* 61 (4): 1410–1464.

Appendix

Figure A1: Raw profits

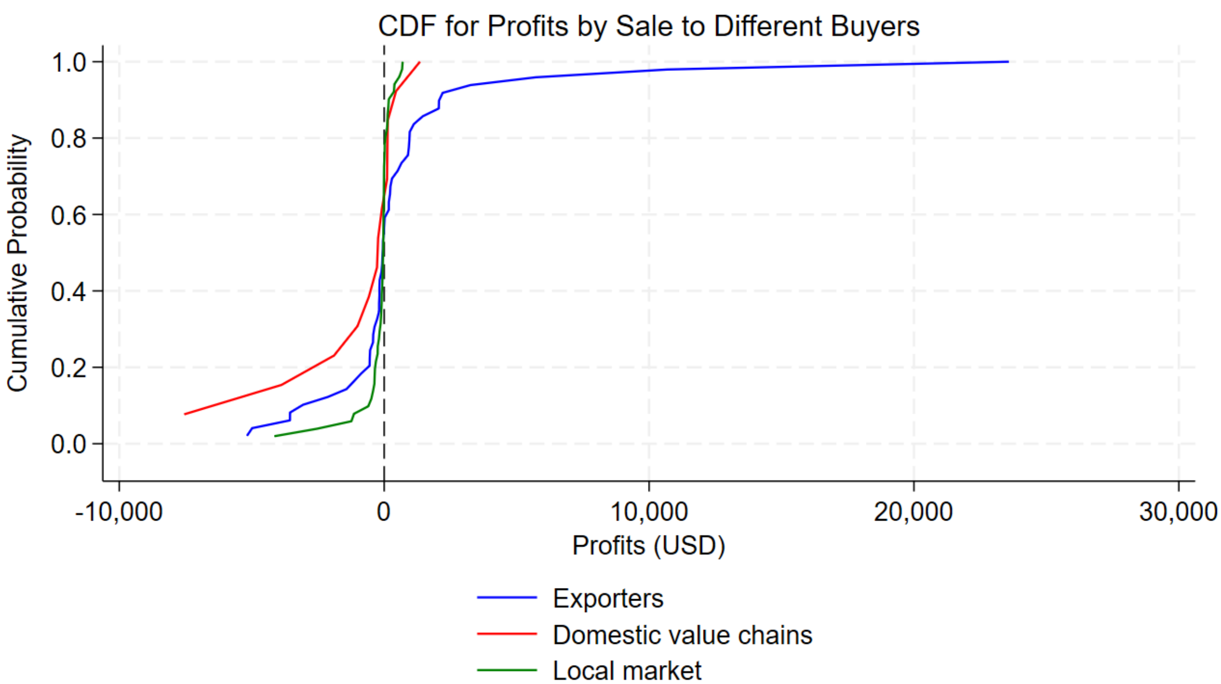
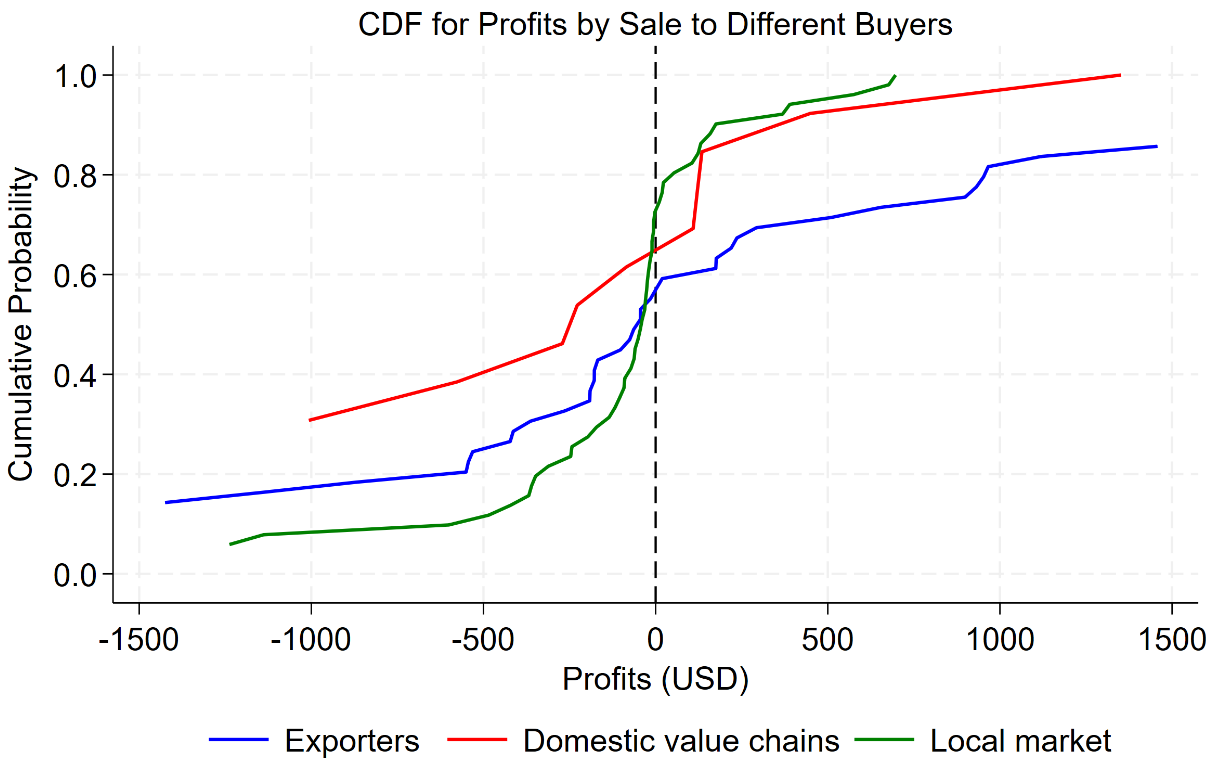


Figure A2: Profits (below $1,500)



theigc.org