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International Trade and Revenue-Based Total Factor Productivity: A Firm-Level Analysis

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Abstract: Economists concur that international trade is conducive to economic growth. However, at the firm level, variation exists. In this article, my goal is to conduct economic analysis on firm-level data and study the productivity effects of trade. With the comprehensive World Bank Enterprise Surveys data, I first explore trade patterns across different firms, controlling for industry, firm size, and the legal status of the firm. I then conduct regression analysis to identify characteristics of firms that participate in trade. Finally, I use an instrumental variable regression to study the causal relationship between a firm's productivity and its participation in trade.

Keywords: international trade, productivity, firm-level analysis, imported intermediates, export.

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I. Introduction

Over time, global economic growth goes in line with the increasing importance of international trade.[2] As of 2019, international trade comprises 60.27% of global GDP.[3] According to the law of comparative advantage, participating countries in international trade specialize in different industries or sectors, leading to a more efficient allocation of resources and increased aggregate economic growth. Although the law of comparative advantage has been repeatedly confirmed at an aggregate level, it is not informative enough regarding the winners and losers from trade at the level of the firm. In other words, we want to know how trade improves firm performance, with a focus on firm productivity for different firms.

A large amount of the international trade literature has studied the firms' gains from trade in response to a variety of trade shocks, including trade reforms, World Trade Organization (WTO) accession, new trade zones, and currency devaluation. Regardless of the types of the trade shocks, international trade can improve firm performance through two distinct channels: increased export opportunities and increased imported intermediates.

On the one hand, increased export opportunities expand the output market, providing domestic firms greater opportunities for specialization and innovation. This affects firm productivity in two ways. First, export opportunities usually help reduce the variety of products firms sell. Iacovone and Javorcik have shown that Mexican exporters under the North American Free Trade Agreement (NAFTA) churned exports as integration deepened.[4] Evidence from Canadian manufacturing firms suggests that non-exporters and small exporters will also reduce diversification after trade shocks.[5] Additionally, U.S. firms reduced product scope after the Canada–United States Free Trade Agreement (CUSFTA).[6] Admittedly, specialization is not universal for firms. For example, foreign-oriented U.S. firms diversified their products after the

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[2] World Bank Group. "Stronger Open Trade Policies Enable Economic Growth for All." 2018. Retrieved from https://www.worldbank.org/en/results/2018/04/03/stronger-open-trade-policies-enables-economic-growth-for-all

[3] World Bank Group. "Trade (% of GDP)." 2021. Retrieved from https://data.worldbank.org/indicator/NE.TRD.GNFS.ZS

[4] Iacovone, Leonardo, and Beata S. Javorcik. "Multi-product exporters: Product churning, uncertainty and export discoveries." *The Economic Journal* 120, no. 544 (2010): 481-499.

[5] Baldwin, John, and Wulong Gu. "The impact of trade on plant scale, production-run length and diversification." In *Producer Dynamics: New Evidence from Micro Data*, pp. 557-592. University of Chicago Press, 2009.

[6] Bernard, Andrew B., Stephen J. Redding, and Peter K. Schott. "Multiproduct firms and trade liberalization." *The Quarterly Journal of Economics* 126, no. 3 (2011): 1271-1318.

CUSFTA.[7] But overall, international trade promotes specialization among firms. Second, export opportunities boost innovation. After the South American trade bloc MERCOSUR reduced Brazilian tariffs for Argentinian firms, firms in industries with higher tariff reductions show faster technological upgrading.[8] Data from 60 countries also suggest that trade liberalization encourages innovation: "A 1 percentage tariff cut in export markets leads to a 2-3 percent growth in firms' knowledge stock."[9]

With increased specialization and innovation, export opportunities bring productivity gains. An analysis of Chilean Total Factor Productivity (TFP) data, for instance, shows that the reduction of export barriers improved productivity for plants in both importing and exporting industries.[10] An examination of sub-Saharan African manufacturing firms also indicates that entry into the export market increased the exporters' productivity.[11] Similarly, the relationship between TFP gains and export opportunities holds for various datasets from Slovenia,[12] China,[13] and Cameroon.[14] In addition to TFP gains from the entry into the export market, firms also obtain labor productivity gains. For example, better access to the U.S. market increased labor productivity for Canadian manufacturing plants.[15]

At the same time, increased imported intermediates may "lower input costs, increase the quality of inputs, and/or improve the efficiency of the production process."[16] That is, increased imported intermediates improve firm productivity. Evidence from 12 European countries shows increases in TFP for firms that import more from China, whose rise "constitutes perhaps the most

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[7] Lopresti, John. "Multiproduct firms and product scope adjustment in trade." *Journal of International Economics* 100 (2016): 160-173.
[8] Bustos, Paula. "Trade liberalization, exports, and technology upgrading: Evidence on the impact of MERCOSUR on Argentinian firms." *American Economic Review* 101, no. 1 (2011): 304-40.
[9] Coelli, Federica, Andreas Moxnes, and Karen Helene Ulltveit-Moe. "Better, faster, stronger: Global innovation and trade liberalization." *Review of Economics and Statistics* (2016): 1-42.
[10] Bas, Maria, and Ivan Ledezma. "Trade integration and within-plant productivity evolution in Chile." *Review of World Economics* 146, no. 1 (2010): 113-146.
[11] Van Biesebroeck, Johannes. "Exporting raises productivity in sub-Saharan African manufacturing firms." *Journal of International Economics* 67, no. 2 (2005): 373-391.
[12] De Loecker, Jan. "Do exports generate higher productivity? Evidence from Slovenia." *Journal of International Economics* 73, no. 1 (2007): 69-98.
[13] Brandt, Loren, Johannes Van Biesebroeck, Luhang Wang, and Yifan Zhang. "WTO accession and performance of Chinese manufacturing firms." *American Economic Review* 107, no. 9 (2017): 2784-2820.
[14] Njikam, Ousmanou, and John Cockburn. "Trade liberalization and productivity growth: firm-level evidence from Cameroon." *The Journal of Developing Areas* (2011): 279-302.
[15] Lileeva, Alla, and Daniel Trefler. "Improved access to foreign markets raises plant-level productivity… for some plants." *The Quarterly Journal of Economics* 125, no. 3 (2010): 1051-1099.
[16] Shu, Pian, and Claudia Steinwender. "The impact of trade liberalization on firm productivity and innovation." *Innovation Policy and the Economy* 19, no. 1 (2019): 39-68.

important exogenous trade shock from low-wage countries to hit the 'Northern' economies."[17] Moreover, Halpern et al. attributed "one-quarter of Hungarian productivity growth during the 1993–2002 period to imported inputs."[18] Similarly, improved access to foreign inputs has been shown to increase productivity for Indonesian, Chilean, and Indian firms.[19] Therefore, increased access to imports can also produce firm-level productivity growth.

Despite the voluminous literature documenting the benefits of trade liberalization, some literature suggests otherwise. For example, data of Swedish firms shows that entry into exporting might not affect firm-level productivity.[20] Similarly, Brazilian data on imported intermediates show that the efficiency difference between foreign and domestic inputs "have a minor bearing on productivity."[21] My first research question therefore involves the confirmation of the relationship between trade and firm-level productivity on a global scale. I would like to know if exports and imported intermediates are significantly associated with productivity as suggested in most literature, and their magnitude of the effects if so.

The literature has also suggested that trade patterns differ by firm. Firm size, among other things, is a crucial criterion in determining whether a firm will participate in and possibly gain from trade. Since the largest five firms in a country can make up 30% of the country's exports,[22] large firms can tremendously benefit from a country's trade liberalization. In fact, large firms in Korea have driven innovation in terms of patent applications during trade with China.[23] Evidence from India also shows that large firms increase their R&D spending when imported inputs increase.[24] My second research question then follows: which firms take part in trade? In other

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[17] Bloom, N., M. Draca, and J. van Reenen. 2016. "Trade Induced Technical Change? The Impact of Chinese Imports on Innovation, IT and Productivity." *Review of Economic Studies* 83 (1): 87–117.
[18] Halpern, L., M. Koren, and A. Szeidl. 2015. "Imported Inputs and Productivity." *American Economic Review* 105 (12): 3660–703.
[19] Ibid.
[20] Greenaway, David, Joakim Gullstrand, and Richard Kneller. "Exporting may not always boost firm productivity." *Review of World Economics* 141, no. 4 (2005): 561-582.
[21] Muendler, Marc-Andreas. "Trade, technology and productivity: a study of brazilian manufacturers 1986-1998." *Technology and Productivity: A Study of Brazilian Manufacturers* 1998 (1986).
[22] Freund, Caroline, and Martha Denisse Pierola. "Export superstars." *Review of Economics and Statistics* 97, no. 5 (2015): 1023-1032.
[23] Ahn, JaeBin, Hyoungmin Han, and Yi Huang. *Trade with benefits: New insights on competition and innovation*. No. 07-2018. Graduate Institute of International and Development Studies Working Paper, 2018.
[24] Goldberg, Pinelopi Koujianou, Amit Kumar Khandelwal, Nina Pavcnik, and Petia Topalova. "Imported intermediate inputs and domestic product growth: Evidence from India." *The Quarterly journal of economics* 125, no. 4 (2010): 1727-1767.

words, what are the characteristics of the firms that can gain from trade? There might be some common characteristics, including firm size, industry, and the legal status.

Finally, the simultaneity problem of exporting firms is worth studying: do firms export because they are productive, or do they become productive because of trade? The Melitz model (2003) shows that after trade shocks, the most productive firms continue to produce and start to export, whereas the least productive firms exit the market.[25] In terms of innovation, data from French firms show that the initially most productive firms innovate more after entering the export market, but the least productive firms innovate less.[26] Therefore, my third question arises: is it trade causing productivity growth or the other way around? To determine adequate trade policies, it's essential to know whether leaning by exports or self-selection plays the primary role.

Therefore, my research primarily intends to answer the three questions listed above: Does international trade imply higher firm productivity on a global scale? What are the characteristics of the firms that participate in trade? What is the direction of causation for productive firms and trade gains?

With comprehensive World Bank Enterprise Surveys data, my research will contribute to the field in two ways. First, since most of the literature uses country-specific or region-specific data within a given time period, my use of a comprehensive dataset will allow for more variation across countries, types of firms, and time. The results will yield more meaningful comparisons than typical datasets would. Additionally, the pool of variables is wider in this dataset because it includes a variety of subjective firm-specific evaluations regarding obstacles faced by each firm. The scope and the depth of such information can provide a good description of the challenges of an industry or a country. Second, my analysis of the dataset involves the use of the instrumental variable approach, which is rarely used in the above-mentioned literature. Therefore, my work will provide a new perspective on how international trade can improve firm-level productivity.

The organization of this paper is as follows: in Section II, I describe the dataset, introduce key variables, and outline the summary statistics; in Section III, I formulate the baseline regression and explore correlational patterns in the data; in Section IV, I seek to find a causal relationship

[25] Melitz, Marc J. "The impact of trade on intra-industry reallocations and aggregate industry productivity." *Econometrica* 71, no. 6 (2003): 1695-1725.
[26] Aghion, P., A. Bergeaud, M. Lequien, and M. Melitz. 2018. "The Impact of Exports on Innovation: Theory and Evidence." *NBER Working Paper* no. 24600, Cambridge, MA.

using an instrumental variable regression; and in Section V, I discuss policy implications of my results and conclude the paper.

II. Data and Distributional Patterns

In this article, four datasets are used. The first dataset is the World Bank Enterprise Surveys data. This dataset collects firm-level "qualitative and quantitative information"[27] through surveys in the "nonagricultural formal private economy."[28] The surveys started in 2006, and were conducted through "face to face interviews with firm managers and owners regarding the business environment in their countries and the productivity of their firms."[29] With "properly designed survey instruments and a uniform sampling methodology,"[30] the dataset provides "statistically significant investment climate indicators that are comparable across countries."[31]

The second dataset is the World Bank Firm Level Productivity Estimates data. Using the World Bank Enterprise Surveys data, the World Bank's Enterprise Analysis unit estimated firms' revenue-based TFP.[32] The estimation is based on the Cobb-Douglas production function:

$$VA_i = A_i K_{i\alpha k} L_{i\alpha l}$$

where firm-level value-added VA_i is a function of inputs of capital (K_i) and labor (L_i), with elasticities αk and αl. In the YKLM specification, VA_i is replaced with output Y_i and the righthand side has an additional input variable, materials (M_i).[33] Under the assumption that markets are perfectly competitive, TFP was "estimated separately for each industry."[34] After removing sectors

[27] World Bank Group. "Enterprise Surveys Indicator Descriptions." 2017. Retrieved from https://www.enterprisesurveys.org/content/dam/enterprisesurveys/documents/Indicator-Descriptions.pdf
[28] Ibid.
[29] Ibid.
[30] World Bank Group. "Sampling Note." 2009. Retrieved from https://www.enterprisesurveys.org/content/dam/enterprisesurveys/documents/methodology/Sampling_Note.pdf
[31] Ibid.
[32] World Bank Group, Enterprise Analysis Unit. 2017. "Firm Level Productivity Estimates." Retrieved from www.enterprisesurveys.org/
[33] Ibid.
[34] Ibid.

that have fewer than 120 observations and converting all currencies into 2009 U.S. Dollars,[35] the YKLM specification of the TFP is estimated. The estimates take into account the survey design of the Enterprise Survey by "incorporating both stratification and probability weight information."[36]

The third dataset is the Gravity dataset from CEPII,[37] which contains information on country-level trade flows. I included the years from 2000—2019. The dataset includes origin country, destination country, and trade volumes.

The fourth dataset is the World Bank GDP data. It collects GDP in current U.S. dollars for almost all countries across the world through "World Bank national accounts data, and OECD National Accounts data files."[38] All the GDP data is converted to 2009 USD using the GDP deflator (as in the TFP calculation) for the United States.[39]

The first two datasets were merged with the unique firm identifier of each interview conducted by the Enterprise Survey. Then the resulting dataset is merged with the trade flow dataset and the GDP dataset using ISO 3 country codes.

After merging the four datasets, the comprehensive dataset contains 49,983 observations. The data ranges from 2006 to 2020 across 136 countries, most of which are low-income and developing countries. Key variables include TFP, *export*, and *import*. As noted above, TFP is an estimate of the revenue-based total factor productivity. It is estimated in the log form and takes values from -6.1 to 10.35. The values of TFP follow the normal distribution. The *export* variable ranges from 0 to 100, representing the share of both direct and indirect exports as a percentage of total sales. The variable *import* is the percentage of the firm's material inputs and supplies of foreign origin in the last fiscal year. Other variables will be specified below.

In the comprehensive dataset, 32.43% of the firms export, and 57.48% of the firms use foreign inputs. Large firms (more than 100 employees) comprise 22.73% of all firms, while medium firms (20-99 employees) comprise 37.39% and small firms (fewer than 20 employees) 39.88%. Firms that export have on average been exporting for 14.76 years, but the average becomes 4.62 if all firms are considered.

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[35] Ibid. The conversion is obtained with the average of official exchange rates from the World Development Indicators and the GDP deflator for the United States for the relevant fiscal year.
[36] Ibid. The documentation has not explained this consideration in detail.
[37] The Gravity database. *CEPII*. Retrieved from http://www.cepii.fr/CEPII/fr/bdd_modele/presentation.asp?id=8
[38] World Bank Group. "GDP (current US$)." Retrieved from https://data.worldbank.org/indicator/NY.GDP.MKTP.CD
[39] World Bank Group. "GDP deflator-United States." Retrieved from https://data.worldbank.org/indicator/NY.GDP.DEFL.ZS?locations=US

A closer look at the data provides further insight into distributional patterns. There is a notable difference in the TFP between firms that participate in trade and those that do not (see Figure 1): participation in exports is associated with higher productivity, while participation in imports is associated with lower productivity.

The relationship between productivity and exports is also found across most industries. As shown in Figure 2, firms that export generally have higher productivity.[40] But this difference is relatively small, as compared with productivity differences across industries. Certain industries, such as "the manufacture of other non-metallic mineral products" (indexed by 26 in ISIC code), have high productivity regardless of the firms' exporting status in that industry. By contrast, "the manufacture of pharmaceuticals, medicinal chemical and botanical products" (indexed by 21 in ISIC code), as an industry, has lower productivity for both exporting and non-exporting firms.

As for imports, the relationship with productivity is less obvious. As in Figure 3, although productivity varies across industries, there is no observable difference between importing and non-importing firms. This is contrary to the finding in the literature; therefore, the *import* variable will be further analyzed.

The data also shows some distributional patterns in terms of participation in trade. From Figure 4 to Figure 7, firms on average import and export more if they possess the following traits: they have larger size; they are shareholding companies with public or private/non-traded shares, and the effect is more obvious if the shares are traded publicly; they have invested in Research and Development in the past fiscal year; or they are located in a high-income country.[41] These distributional patterns will be further studied in the following sections.

Despite the variation in the data in terms of countries and years, most of the firms in the dataset were interviewed only once. There is a very limited number of firms that contain panel data. Therefore, in the following analysis, I will treat the dataset as cross-sectional data, and I will control for country and year fixed effects.

[40] The industries are grouped by the ISIC (the International Standard Industrial Classification of All Economic Activities).
[41] Classified by the World Bank at a given year for each country.

III. The Baseline Regression and Correlational Patterns

To start with, I construct the baseline regression with only the three key variables and the fixed effects for country and year:

$$\text{TFP} = \beta_0 + \beta_1 \,\text{export} + \beta_2 \,\text{import} + \text{FE}_c + \text{FE}_t + u$$

With robust standard errors, both *export* and *import* are significant at the 1% level (see Column 1 in Table 1). From the baseline regression, the TFP is positively correlated with the extent of a firm's exports. This is what the literature would suggest, and a 10 percentage point increase in exports in terms of total sales is associated with a 3.3% increase in the TFP. However, contrary to what international economists would expect, a 10 percentage point increase in foreign inputs is associated with a 7.4% decrease in the TFP. This discrepancy is interesting and will be further studied as more variables are included and separate regressions are performed.

Building on the baseline regression, new variables are gradually introduced to allow for more variation and comparison. The following regression is generated:

$$\begin{aligned}\text{TFP} = {} & \beta_0 + \beta_1 \,\text{export} + \beta_2 \,\text{import} + \beta_3 \,\text{year\_of\_export} + \beta_4 \,\text{medium\_size} + \beta_5 \,\text{large\_size} + \beta_6 \,\text{shareholdingpublic} + \beta_7 \,\text{shareholdingprive} + \beta_8 \,\text{foreign\_tech} \\ & + \beta_9 \,\text{RD} + \beta_{10} \,\text{loss\_theft} + \beta_{11} \,\text{lgdp09} + \beta_{12} \,\text{major\_tax\_obstacle} + \beta_{13} \,\text{severe\_tax\_obstacle} + \beta_{14} \,\text{major\_political\_obstacle} + \beta_{15} \,\text{severe\_political\_obstacle} + \text{FE}_{\text{isic}} + \text{FE}_c + \text{FE}_t + u\end{aligned}$$

In the regression above, *year_of_export* indicates how many years a firm has been exporting. *medium_size* and *large_size* are two indicator variables, respectively for the firm size of 20-99 employees and the firm size of more than 99 employees. *shareholdingpublic* and *shareholdingprive* are indicator variables, referring to firms with shares traded in the stock market and those with non-traded or private shares. *foreign_tech* is an indicator variable and equal to 1 if the firm used technology licensed from a foreign company in the past fiscal year. *RD* is an indicator variable and is 1 if the firm spent on research and development (excluding market research) in the past fiscal year. *loss_theft* is an indicator variable referring to whether the firm has experienced

losses due to theft, robbery, vandalism, or arson during the last fiscal year. *lgdp09* is a numeral variable that contains the log of GDP of the firm's country in a given year in terms of 2009 U.S. dollars. *major_tax_obstacle*, *severe_tax_obstacle*, *major_political_obstacle*, and *severe_political_obstacle* are all self-reported (by the interviewed person of the firm) indicator variables specifying whether the firm is facing major or severe obstacle for either tax or political reasons. The dataset contains five levels of obstacles: no, minor, moderate, major, and severe (in increasing order); for the regression, the inclusion of two levels should render enough insight. FE_{isic} is the fixed effect for different industries based on the ISIC. Since the GDP data is only available until 2019, the year fixed effect FE_t only covers years 2006-2019. β_0 is the constant and u is the residual.

The reasons to include the above variables are as follows. The inclusion of *year_of_export* assumes that, if a firm has been exporting for a long time, it is more likely to be familiar with the market and potentially gain more from trade. Firm size, as discussed earlier, is theoretically related with high productivity; additionally, the causal direction between firm size and productivity is of concern. The legal status of the firm is included with variables *shareholdingpublic* and *shareholdingprive* because it is important to know whether a firm with any form of shares is more productive than firms with other types of legal status, as indicated in Figure 5. The inclusion of *foreign_tech* and *RD* is based on the assumption that firms that invest in innovation and are less reliant on foreign technology can perform better. The *loss_theft* variable is also relevant for productivity because it indicates the security work of the firm or even the overall security of the country. The variable *lgdp09* is included because a firm's performance is not only firm-specific but also affected by the macroeconomic environment. The last four indicator variables of obstacles are included with a similar purpose as the *lgdp09* variable: to control for macroeconomic environment—the obstacle measure is distinct from the GDP measure because the extent of the obstacles is firm-specific.

	(1) TFP	(2) TFP	(3) TFP	(4) TFP	(5) TFP	(6) TFP	(7) TFP	(8) TFP
export	0.00331***	0.000880***	0.000669***	0.000361**	0.000349*	0.000395*	0.000415*	0.000415*
	(8.77)	(7.57)	(4.86)	(2.58)	(2.49)	(2.38)	(2.47)	(2.47)
import	-0.00741***	0.000296**	0.000254*	0.0000838	0.0000787	0.0000428	0.0000585	0.0000585
	(-22.58)	(3.05)	(2.52)	(0.83)	(0.78)	(0.35)	(0.47)	(0.47)
year_of_ex~t			0.000797*	-0.000296	-0.000298	-0.000159	-0.000212	-0.000212
			(2.10)	(-0.76)	(-0.76)	(-0.35)	(-0.47)	(-0.47)
medium_size				0.100***	0.0977***	0.0906***	0.0897***	0.0897***
				(14.29)	(13.63)	(10.43)	(10.20)	(10.20)
large_size				0.127***	0.121***	0.125***	0.123***	0.123***
				(13.78)	(12.65)	(10.82)	(10.55)	(10.55)
shareholdi~c					0.0278	0.0457*	0.0464*	0.0464*
					(1.59)	(2.15)	(2.17)	(2.17)
shareholdi~e					0.0229**	0.0351***	0.0374***	0.0374***
					(2.74)	(3.46)	(3.65)	(3.65)
foreign_tech						0.00214	0.00173	0.00173
						(0.19)	(0.16)	(0.16)
RD						0.0103	0.0111	0.0111
						(1.15)	(1.23)	(1.23)
loss_theft						-0.00193	-0.000426	-0.000426
						(-0.19)	(-0.04)	(-0.04)
lgdp						0.274***	0.262***	0.262***
						(5.49)	(5.21)	(5.21)
major_tax_~e							0.00184	0.00184
							(0.19)	(0.19)
severe_tax~e							-0.0414**	-0.0414**
							(-3.18)	(-3.18)
major_poli~e							-0.0250*	-0.0250*
							(-2.42)	(-2.42)
severe_pol~e							-0.0127	-0.0127
							(-1.05)	(-1.05)
_cons	3.063***	1.917***	1.931***	1.895***	1.892***	-4.516***	-4.224***	-4.224***
	(9.03)	(13.71)	(13.79)	(13.55)	(13.54)	(-3.58)	(-3.33)	(-3.33)
Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Country FE	Y	Y	Y	Y	Y	Y	Y	Y
Industry FE	N	Y	Y	Y	Y	Y	Y	Y
Obs	47570	47570	44891	44891	44484	31588	30753	30753
R-Squared	0.0431	0.930	0.930	0.930	0.931	0.929	0.930	0.930

t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Table 1: Regression Results from the Baseline OLS to Full Model.

I obtained the regression results in Table 1 by gradually introducing the variables listed above. For all regressions, robust standard errors are applied. Columns 1-7 show the gradual introduction of variables, while Column 8 is run with the full model but excluding years 2008, 2009, and 2020. The results from Column 8 coincide with those from Column 7.

From the regression results, *export* is consistently statistically significant, although the effect is relatively small as the full model is built. With the full model, A 10 percentage point increase in exports in terms of total sales will lead to a 0.415% increase in TFP. This result is consistent with the literature in terms of the relationship between TFP and *export*. However, its magnitude cannot be easily compared with the results in the literature, since the approaches are different, and their data more often include time-series data.

The variable *import*, by contrast, is no longer significant after firm size variables are included. The point estimates for *import* under the full model is 0.0000585, indicating the relationship between TFP and *import* is weak, not to mention that *import* is not statistically significant.

Additionally, higher TFP is associated with larger firms, shareholding firms (especially those with publicly traded shares), firms that are in higher income countries, and firms that do not face severe tax obstacles. Other variables, such as years in export, investment in research and development, use of foreign licensed technology, losses due to theft, and the existence of political obstacles, are not significantly correlated with TFP.

The gradual inclusion of variables provides valuable insights into the importance of each set of variables. The fixed effects for industry, for example, tremendously increases the model's explanatory power in terms of the R^2. Firm size is always significant at the 1% level, showing that it is critically related to the firm's productivity level. Similarly, a tight relationship exists between the TFP and GDP for the country where the firm is located. Also, it's notable that as more controls are introduced, the coefficients of *export* fall in terms of magnitude and statistical significance. The coefficients of *import* are rather chaotic: in the baseline regression, its coefficient was negative yet statistically significant. But as the model builds up, the coefficients of *import* become positive and decrease in both magnitude and statistical significance. This potentially results from an initially weak correlation between TFP and *import*—as more controls are introduced, the correlation between the two variables becomes negligible.

The inclusion of Column 8 in Table 1 is to sort out systematic shocks to firms, which can affect the TFP disproportionally due to the 2008 financial crisis and the coronavirus in 2020. The results are coincidentally the same as the results in the full model because of the truncation of different variables in certain years—this truncation is not always the same across different columns.

The results from regressions above, therefore, answer my first research question: On a global scale, participation in exports is correlated with higher firm-level productivity; but for imports, there is no significant correlation.

Exporter Premia in Firms, 2006-2020

	Exporter premia		
	1	2	3
TFP	0.027	0.022	0.068***
log number of employees	1.218***	1.228***	1.220***
log sales (2009$)	2.017***	1.647***	1.658***
Additional covariates	None	Country and year fixed effects	Country, year, and industry fixed effects

Table 2: Exporter Premia in Firms, 2006-2020.

Note: this approach replicates the approach used by Bernard et al.

Since only exports appear to matter, separate regressions are run on the dummy variable *Export*, which indicates whether a firm is exporting. The regressions examined the dummy variable's correlation with three other variables: TFP, the log of the number of employees, and the log of total sales (see Table 2). With robust standard errors, the results are consistent with the regression model in Table 1: for TFP, *Export* is significant when industry fixed effect is included; for log number of employees and log sales, *Export* is always positively correlated with them at the 1% level. The results of TFP indicate that the industry especially matters for a firm, and it is crucial to include the industry fixed effects.

My results resemble Bernard et al.'s results but the estimates are higher. In their results, the exporter premium for TFP is 0.03 with industry fixed effects and significant at the 1% level.[42] The exporter premium for TFP in Table 3 is 0.068 with year, country, and industry fixed effects, also significant at the 1% level. Their exporter premium for log employment is 0.97 after industry fixed effects, and the result in Table 3 is 1.220. In both cases, the significance level is 1%.

Therefore, exporting firms tend to have higher TFP, total sales, and the number of employees. This is consistent with the literature and the OLS results in Table 1.

[42] Bernard, Andrew B., J. Bradford Jensen, Stephen J. Redding, and Peter K. Schott. "Firms in international trade." *Journal of Economic perspectives* 21, no. 3 (2007): 105-130.

The finding of the regressions above paves the path to answering my second research question: Which firms trade more? To answer this question, I run regressions with robust standard errors and gradually introduced variables for both *import* and *export*.

For *import*, the variables of concern are specified in Table 3. Most of the variables are the same as in the main regression model for TFP, except *import_custom*, which is the average number of days for imported goods to clear customs. In the results, Column 1 to Column 6 represent regression results of all non-importing and importing firms, whereas Column 7 is the result for importing firms only. Column 7 is included to examine whether the trend in the full regression model (Column 6) still holds when only importing firms are concerned.

The results from Table 3 show that firms' use of foreign licensed technology is significantly correlated with importing. In the full model (Column 6 in Table 3), if a firm uses foreign licensed technology, it is predicted to have 6.084 percentage points more imports in terms of total inputs than those without foreign technology. This suggests that foreign technology might require foreign inputs, or the use of foreign technology indicates the firm's reliance on foreign inputs. Also, the more a firm exports, the more it imports. A 10 percentage point increase in exports is associated with a 1.25 percentage point increase in imports. This implies that a firm's involvement in trade is consistent for both importing and exporting. Additionally, a longer time in customs predicts a higher share of imports in total inputs. Every extra day in customs is associated with a 0.484 percentage point increase in imports as a share of total inputs. This happens potentially due to large importers have bigger volumes of imported goods, which take a longer time to clear customs.

The discrepancy between the full model and the model with only importing firms reveals critical insights. First, for firms of different sizes, larger firms are more likely than smaller firms to import, but the magnitude of their imports is smaller. In Column 6, the results show that large firms import 6.158 percentage points more than small firms, and medium firms import 2.574 percentage points more than small firms. But in Column 7, importing large firms import 1.458 percentage points less than small firms, and importing medium firms import 1.806 percentage points less than small firms. Therefore, although an average large firm imports more than an average small firm, small firms are importing the most across all importing firms.

	(1) import	(2) import	(3) import	(4) import	(5) import	(6) import	(7) import
foreign_tech	12.77***	11.15***	7.757***	7.633***	6.628***	6.084***	2.709***
	(29.25)	(26.74)	(18.33)	(17.93)	(13.74)	(12.58)	(4.98)
export			0.136***	0.133***	0.128***	0.125***	0.0573***
			(22.36)	(21.82)	(18.82)	(18.22)	(7.21)
medium_size			4.802***	4.337***	3.615***	2.574***	-1.806***
			(14.40)	(12.74)	(9.36)	(6.72)	(-3.40)
large_size			9.258***	8.598***	7.928***	6.158***	-1.458*
			(22.42)	(19.93)	(16.39)	(12.69)	(-2.31)
shareholdi~c				0.0899	0.563	-0.0344	-2.676**
				(0.12)	(0.70)	(-0.04)	(-2.83)
shareholdi~e				3.914***	3.487***	2.854***	0.0789
				(9.85)	(7.50)	(6.19)	(0.14)
RD					2.550***	1.818***	-1.202*
					(6.09)	(4.34)	(-2.46)
import_cus~m						0.484***	0.0743***
						(19.09)	(4.52)
_cons	53.69***	61.80***	59.83***	58.59***	53.37***	53.52***	74.72***
	(8.41)	(9.31)	(8.93)	(8.76)	(3.46)	(3.61)	(6.47)
Year FE	Y	Y	Y	Y	Y	Y	Y
Country FE	Y	Y	Y	Y	Y	Y	Y
Industry FE	N	Y	Y	Y	Y	Y	Y
Obs	47245	47245	47180	46772	35092	34467	19210
R-Squared	0.169	0.244	0.269	0.270	0.285	0.303	0.200

t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Table 3: Regression Results for import.

Second, the legal status of the firm is not a reliable predictor of the firm's imports because of the change of significance levels across Column 6 and Column 7. For all the firms, shareholding firms with private or non-traded shares import 2.854 percentage points (as a share of inputs) more than other types of firms, but for importing firms, shareholding firms with publicly traded shares import 2.676 percentage points (as a share of inputs) less. Moreover, for firms with publicly traded shares, the coefficient changed from insignificant to significant at the 1% level when only importing firms are concerned. By comparison, for firms with private or non-traded shares, the coefficient changed from significant at the 1% level to insignificant. These results show that there is no easy conclusion to explain the importing behavior based on firms' legal status.

Third, the investment in research and development has mixed effects. Overall, R&D boosts imports by 1.818 percentage points (as a share of inputs) for firms, but such an investment indicates 1.202 percentage points (as a share of inputs) less imports for importing firms. Therefore, although R&D is associated with high imports for all firms, importing firms without R&D import more. One possible explanation is that importing firms might rely on foreign inputs and not investing in R&D as often—this can also be an explanation for why there is a negative correlation between TFP and *import* as shown in the baseline regression.

Despite the difference between the results for all firms and the results for importing firms, firms that participate in importing generally have the following characteristics: the use of foreign technology, participation in exporting, large firm size, and investment in R&D.

As for *export*, the regressions are run similarly as for the *import* regression, and the results are in Table 4. Although most of the variables are the same, there are a few differences between these two sets of regressions. One difference is that the *export* regression includes *export_custom*, the average number of days for exports to clear customs, instead of *import_custom* as in the *import* case. Another difference is the inclusion of the variable *year_of_export*, which is possibly indicative of a firm's ability to export more. There are also two new variables: *severe_obstacle* and *major_obstacle*, which are two indicator variables showing how much customs and trade regulations are an obstacle for the firm (self-reported; severe is higher than major). For these two variables, there are three lower obstacle levels not included in the regressions: no obstacle, minor obstacle, and moderate obstacle. The inclusion of these two variables is based on the assumption that firms might export less when there are major or severe trade obstacles. These two variables are only included in the *export* regressions because exports are statistically significantly correlated with TFP, but imports are not.

For the results in Table 4, Column 1-6 are results that contain all exporting and non-exporting firms, and Column 7 is the result for exporting firms only. This distinction is made to allow comparisons and reveal characteristics about exporting firms, as in the *import* case.

The results show that *year_of_export* is consistently significant at the 1% level. Under the full model (Column 6), one additional year in export is associated with a 1.409 percentage points increase in exports in terms of total sales. Under the exporting firm model (Column 7), the effect is still significant at the 1% level although the point estimate becomes 0.357. Therefore, it is clear that the longer a firm has been exporting, the larger share of its sales is accounted for by exports.

Additionally, a firm's extent of importing is positively correlated with its exporting. Under the full model, a 10 percentage point increase in imports is associated with a 0.584 percentage point increase in exports (as a share of total sales). For exporting firms, the effect is close: a 0.597 percentage point increase follows a 10 percentage points increase in imports. Both results are significant at the 1% level. This result is similar to the result in Table 3, but the difference is that exports seem to have a bigger impact on imports than the other way around.

	(1) export	(2) export	(3) export	(4) export	(5) export	(6) export	(7) export
year_of_ex~t	1.652***	1.621***	1.424***	1.427***	1.397***	1.409***	0.357***
	(53.72)	(53.65)	(46.23)	(45.81)	(44.03)	(41.47)	(12.41)
import			0.0704***	0.0688***	0.0638***	0.0584***	0.0597***
			(18.36)	(17.85)	(14.30)	(12.29)	(5.75)
medium_size			3.702***	3.552***	2.908***	2.716***	1.416
			(16.62)	(15.61)	(11.27)	(9.88)	(1.53)
large_size			11.11***	10.99***	9.289***	8.603***	5.636***
			(29.25)	(28.30)	(21.63)	(19.19)	(5.67)
shareholdi~c				-1.374*	-0.802	-0.353	0.261
				(-2.09)	(-1.09)	(-0.47)	(0.20)
shareholdi~e				1.386***	1.124**	1.263***	0.864
				(4.56)	(3.22)	(3.38)	(1.02)
foreign_tech					3.213***	2.812***	1.104
					(7.43)	(6.27)	(1.53)
RD					1.606***	1.516***	-0.873
					(4.50)	(4.02)	(-1.26)
export_cus~m						0.108*	0.0180
						(2.08)	(1.27)
severe_obs~e						2.571***	1.669
						(3.34)	(1.23)
major_obst~e						1.279*	-0.0310
						(2.52)	(-0.03)
_cons	-0.816	5.244	-0.883	-1.285	-6.087	-5.695	-7.853
	(-0.28)	(1.83)	(-0.31)	(-0.45)	(-1.77)	(-1.69)	(-0.97)
Year FE	Y	Y	Y	Y	Y	Y	Y
Country FE	Y	Y	Y	Y	Y	Y	Y
Industry FE	N	Y	Y	Y	Y	Y	Y
Obs	47150	47150	44891	44484	34299	30491	10335
R-Squared	0.387	0.410	0.431	0.432	0.443	0.440	0.258

t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Table 4: Regression Results for export.

Also, firms of larger size export more frequently and in a greater share of their total sales. For large firms under the full model, they export 8.603 percentage points (as a share of total sales) more than small firms. At the same time, medium firms export 2.716 percentage points (as a share of total sales) more than small firms. Even under the exporting firm model, large firms still export 5.636 percentage points (as a share of total sales) more than small firms. All the above results are significant at the 1% level. Therefore, the implication is that larger firms export more often than their smaller counterparts, and they export in greater shares of their total sales.

Other variables also show valuable insights. Although not significantly correlated with firms that are already exporting, the following characteristics are significant if non-exporting firms are taken into account: being a shareholding company with private or non-traded shares; investing in R&D; and using foreign licensed technology. In other words, if we have no prior knowledge of whether a firm is exporting, these characteristics are valid predictors for its extent of exporting.

Additionally, firms export more if they face a higher number of days in customs for exporting or face major or severe obstacles in exporting. The explanation for this can be similar to

the case of time in customs for importing firms: because firms export more, they are more likely to face difficulties in customs.

Therefore, from the two sets of regressions above, my second research question has been answered. Firms import more in the following situations: when they use foreign licensed technology; when they are large firms; when they export; and when they invest in R&D. Firms also import more when they spend longer time clearing customs. Firms export more in the following situations: when they have been exporting for a long time; when they are large firms; when they import; and when they invest in R&D. Firms also export more when they have major or severe obstacles in trade and customs or spend a long time in clearing customs. Other variables have limited explanatory power.

IV. The Instrumental Variable Regression and Causal Patterns

The third research question seeks to solve the possible reverse causality of the relationship between TFP and exports to determine whether trade leads to TFP increases or high TFP firms select to export. As shown in Section III, *export* is significantly correlated with TFP, but *import* is not. Therefore, I construct an instrument for the variable *export* in a two-stage least-squares instrumental variable regression, while including *import* as a control variable. Other variables are the same as in the main model of the TFP regression, as shown in Column 7 in Table 1.

To determine the causal relationship between TFP and *export*, it is crucial to find an instrument that is not directly correlated with TFP but is a good proxy for *export*. Since the TFP is at the firm level, ideally the instrument should also contain firm-specific information to allow for variation and make the best use of the dataset. At the same time, country-level information is desirable to allow for variation on the aggregate country level. To be valid for use, the instrument should be exogenous to country-specific shocks—for example, a specific country's trade policies, corrupt institutions, or sudden economic crises such as hyperinflation or government deficit. Because if these variations are not treated, it is likely that exporting behaviors of a firm and its productivity are simultaneously affected by some other cause, such as the country-specific shocks mentioned above.

With the concerns listed above, I constructed the instrumental variable in a twofold manner: it includes firm-level information as well as country-level information to allow for variation while controlling for country-specific shocks. First, for each firm in a given country in a given year, I calculate the average number of days for all other firms to clear customs with their exports. The resulting new variable is called *custom_average*. This variable intends to capture how much each firm is involved in exporting. By measuring other firms' time in customs within a given country in a year, *custom_average* is not directly related with TFP of a specific firm. In this manner, this variable contains sufficient variation for each firm while maintains exogeneity on the firm level.

Second, for country-specific shocks, I generate a new variable *weighted_exports* with the trade flow data using the equation below:

$$weighted\_exports_{it} = \sum_{j} \frac{volume_{ijt}}{total\_export_{it}} * (total\_import_{jt} - volume_{ijt})$$

In the equation, *i* is the origin country, *j* is the destination country, and *t* is the year. $volume_{ijt}$ is the trade volume between the two countries in a given year, $total\_export_{it}$ is the total exports for a given origin country in a given year, and $total\_import_{jt}$ is the total imports for a given destination country in a given year.

The new variable $weighted\_exports_{it}$ intuitively captures the relative importance of a country's exports in the world. Its use ensures country-level exogeneity because it is independent of the trade policies of country *i*. In other words, the change in $weighted\_exports_{it}$ is more likely a result of external demand changes. For example, even if the exporting country *i* faces severe economic shock in year *t*, say it reduces its exports by half, other countries' imports are not likely to change much due to the shock in country *i*. Mathematically, even if country *i* adjusts its trade shares with other countries, $total\_import_{jt}$, which is a large number, changes little. At the same time, the export shares ($volume_{ijt}$ divided by $total\_export_{it}$) will always sum to 1. Thus, $weighted\_exports_{it}$ changes little due to the summation of each destination country *j*. Therefore, the economy of the origin country *i* in a year would slightly affect the variable *weighted_exports*.

To incorporate the two levels, *custom_average* and *weighted_exports* are multiplied. The instrument is then generated by taking log for the product of *custom_average* and *weighted_exports*—this is done to get rid of outliers. The resulting instrument therefore includes

both firm-level variation based on time in customs and country-level information based on volumes of trade. Both variables are theoretically supportive of trade. On the one hand, the results from *export* regressions in Section III show that a longer time in customs is associated with higher exports. On the other hand, larger trade volumes are associated with more trade. Therefore, the instrument indicates whether different customs times matter more for firms in countries with larger export shocks. More importantly, the instrument is not correlated with its TFP level because the time for other exporting firms to clear customs and the demand in other countries are unrelated with a specific firm's productivity level.

Then a two-stage least-squares instrumental variable regression is run on the full model (using variables specified in Column 7 in Table 1), with *export* being instrumented. The result is shown in Column 2 in Table 6, with Column 1 as the first stage. Despite the validity of the instrument with an F-statistics at 38.8453 (see Table 5), there appears no significant relationship between TFP and *export*.

Since the results show that exports do not cause TFP to rise, the mechanism behind the Melitz paper is probably working: Productive firms self-select into international trade. That is, productive firms export more but international trade does not significantly make the firms productive. This explanation is compatible with the regression results from Table 1 and Table 4: large firms are usually productive, and they participate in trade more often.

First-stage regression summary statistics

Variable	R-sq.	Adjusted R-sq.	Partial R-sq.	F(1,23793)	Prob > F
export	**0.4121**	**0.4086**	**0.0016**	**38.8453**	**0.0000**

Minimum eigenvalue statistic = **38.8453**

Critical Values	# of endogenous regressors:	**1**
Ho: Instruments are weak	# of excluded instruments:	**1**

	5%	10%	20%	30%
2SLS relative bias		(not available)		

	10%	15%	20%	25%
2SLS Size of nominal 5% Wald test	**16.38**	**8.96**	**6.66**	**5.53**
LIML Size of nominal 5% Wald test	**16.38**	**8.96**	**6.66**	**5.53**

Table 5: IV Regression First Stage Statistics.

	(1) export	(2) TFP
instrument	-6.751***	
	(-6.23)	
import	0.0483***	0.000553*
	(10.33)	(2.09)
year_of_ex~t	1.443***	0.00826
	(88.13)	(1.21)
medium_size	2.286***	0.0972***
	(6.76)	(6.58)
large_size	7.833***	0.183***
	(18.12)	(4.67)
shareholdi~c	-0.225	0.0714**
	(-0.29)	(3.13)
shareholdi~e	1.841***	0.0581***
	(4.69)	(4.07)
foreign_tech	2.470***	0.0231
	(5.83)	(1.35)
RD	1.642***	0.0183
	(4.68)	(1.42)
loss_theft	-2.294***	-0.0189
	(-5.99)	(-1.21)
lgdp	-3.576	0.124*
	(-1.85)	(2.09)
major_tax_~e	-1.903***	-0.0109
	(-5.13)	(-0.78)
severe_tax~e	-1.540**	-0.0430*
	(-2.92)	(-2.51)
major_poli~e	-0.225	-0.0339**
	(-0.58)	(-2.96)
severe_pol~e	0.642	-0.0192
	(1.41)	(-1.41)
export		-0.00545
		(-1.16)
_cons	221.5***	-0.799
	(4.46)	(-0.59)
Obs	23935	23935

t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Table 6: Results for IV Regression.

Note: the construction of the country-level component of the instrument imitates the instrument in the Hummels paper.[43]

[43] Hummels, David, Rasmus Jørgensen, Jakob Munch, and Chong Xiang. "The wage effects of offshoring: Evidence from Danish matched worker-firm data." *American Economic Review* 104, no. 6 (2014): 1597-1629.

V. Conclusion

So far, my three research questions have all been answered. First, there is a positive correlation between firm-level productivity and exporting. A 10 percentage point increase in exports is associated with a 0.4% increase in TFP. However, no significant correlation exists between productivity and importing. The insignificance is possibly due to a mixture of relying on imports and benefiting from imports, as indicated by the *RD* variable in the regressions on *import*, which displays a change of the sign in the coefficient when only importing firms are concerned. A few other variables are also significantly correlated with TFP, including firm size, the legal status of the firm, the country's GDP (in log form), and the tax obstacle the firm faces.

Second, exporting firms are more likely to import and vice versa. Firms with the following traits are more likely to trade: the use of foreign technology; the large firm size; the investment in R&D; the long time in clearing customs. Exports are also related with the length of time for a firm in exporting business. When non-exporting or non-importing firms are neglected, the traits are slightly different.

Third, the results from the instrumental variable regression indicate that exports do not lead to high productivity. It is more likely that it is the other way around. That is, productive firms, which are usually large, select into international trade.

My research, therefore, adds to the literature of international trade on the firms in trade and the simultaneity problem—this paper can in part support the Melitz model (2003). At the same time, this paper's findings provide some policy implications. As an exporter, a country's trade policies should focus on the most productive sectors of the economy. As an importer, a country should be careful in drafting trade policies because the imports are from the most productive firms abroad and might outcompete domestic firms if protections are not adequate. The lesson for the firms is much simpler: choosing the productive industry is a great start. It would also be beneficial for the firms to learn from foreign competitors that enter the domestic market because they are usually more productive.

Admittedly, my research is limited in terms of scope and analysis. Future research can make use of panel datasets for firms on a global scale if that information becomes valuable. In this way, researchers may conduct more thorough economic analysis with time-series methods. Besides, future research can include developed countries into the dataset and make a

comprehensive comparison between high-income and low-income countries. As of now, the comprehensive dataset does not contain key developed countries such as the United States, Canada, and Western European countries. It focuses extensively on developing countries, and valuable insights might be drawn if a more inclusive dataset is collected. Additionally, more analysis can be done to study heterogeneous firms to confirm the relationship between productive firms and their selection into exporting. That would be a step forward from the results of the instrumental variable regression in this paper.

References

Aghion, P., A. Bergeaud, M. Lequien, and M. Melitz. 2018. “The Impact of Exports on Innovation: Theory and Evidence.” *NBER Working Paper* no. 24600, Cambridge, MA.

Ahn, JaeBin, Hyoungmin Han, and Yi Huang. *Trade with benefits: New insights on competition and innovation*. No. 07-2018. Graduate Institute of International and Development Studies Working Paper, 2018.

Baldwin, John, and Wulong Gu. "The impact of trade on plant scale, production-run length and diversification." *In Producer Dynamics: New Evidence from Micro Data*, pp. 557-592. University of Chicago Press, 2009.

Bas, Maria, and Ivan Ledezma. "Trade integration and within-plant productivity evolution in Chile." *Review of World Economics* 146, no. 1 (2010): 113-146.

Bernard, Andrew B., J. Bradford Jensen, Stephen J. Redding, and Peter K. Schott. "Firms in international trade." Journal of Economic perspectives 21, no. 3 (2007): 105-130.

Bernard, Andrew B., Stephen J. Redding, and Peter K. Schott. "Multiproduct firms and trade liberalization." *The Quarterly Journal of Economics* 126, no. 3 (2011): 1271-1318.

Bloom, N., M. Draca, and J. van Reenen. 2016. “Trade Induced Technical Change? The Impact of Chinese Imports on Innovation, IT and Productivity.” *Review of Economic Studies* 83 (1): 87–117.

Brandt, Loren, Johannes Van Biesebroeck, Luhang Wang, and Yifan Zhang. "WTO accession and performance of Chinese manufacturing firms." *American Economic Review* 107, no. 9 (2017): 2784-2820.

Bustos, Paula. "Trade liberalization, exports, and technology upgrading: Evidence on the impact of MERCOSUR on Argentinian firms." *American Economic Review* 101, no. 1 (2011): 304-40.

Coelli, Federica, Andreas Moxnes, and Karen Helene Ulltveit-Moe. "Better, faster, stronger: Global innovation and trade liberalization." *Review of Economics and Statistics* (2016): 1-42.

De Loecker, Jan. "Do exports generate higher productivity? Evidence from Slovenia." *Journal of International Economics* 73, no. 1 (2007): 69-98.

Freund, Caroline, and Martha Denisse Pierola. "Export superstars." *Review of Economics and Statistics* 97, no. 5 (2015): 1023-1032.

Goldberg, Pinelopi Koujianou, Amit Kumar Khandelwal, Nina Pavcnik, and Petia Topalova. "Imported intermediate inputs and domestic product growth: Evidence from India." *The Quarterly journal of economics* 125, no. 4 (2010): 1727-1767.

Greenaway, David, Joakim Gullstrand, and Richard Kneller. "Exporting may not always boost firm productivity." *Review of World Economics* 141, no. 4 (2005): 561-582.

Halpern, L., M. Koren, and A. Szeidl. 2015. "Imported Inputs and Productivity." *American Economic Review* 105 (12): 3660–703.

Hummels, David, Rasmus Jørgensen, Jakob Munch, and Chong Xiang. "The wage effects of offshoring: Evidence from Danish matched worker-firm data." *American Economic Review* 104, no. 6 (2014): 1597-1629.

Iacovone, Leonardo, and Beata S. Javorcik. "Multi-product exporters: Product churning, uncertainty and export discoveries." *The Economic Journal* 120, no. 544 (2010): 481-499.

International Labor Organization. "the International Standard Industrial Classification of All Economic Activities (ISIC)." Retrieved from https://ilostat.ilo.org/resources/concepts-and-definitions/classification-economic-activities/

Lileeva, Alla, and Daniel Trefler. "Improved access to foreign markets raises plant-level productivity… for some plants." *The Quarterly Journal of Economics* 125, no. 3 (2010): 1051-1099.

Lopresti, John. "Multiproduct firms and product scope adjustment in trade." *Journal of International Economics* 100 (2016): 160-173.

Melitz, Marc J. "The impact of trade on intra-industry reallocations and aggregate industry productivity." *Econometrica* 71, no. 6 (2003): 1695-1725.

Muendler, Marc-Andreas. "Trade, technology and productivity: a study of brazilian manufacturers 1986-1998." *Technology and Productivity: A Study of Brazilian Manufacturers* 1998 (1986).

Njikam, Ousmanou, and John Cockburn. "Trade liberalization and productivity growth: firm-level evidence from Cameroon." *The Journal of Developing Areas* (2011): 279-302.

Shu, Pian, and Claudia Steinwender. "The impact of trade liberalization on firm productivity and innovation." I*nnovation Policy and the Economy* 19, no. 1 (2019): 39-68.

The Gravity database. CEPII. Retrieved from http://www.cepii.fr/CEPII/fr/bdd_modele/presentation.asp?id=8

World Bank Group, Enterprise Analysis Unit. 2017. "Firm Level Productivity Estimates." Retrieved from www.enterprisesurveys.org/

World Bank Group. “Enterprise Surveys Indicator Descriptions.” 2017. Retrieved from https://www.enterprisesurveys.org/content/dam/enterprisesurveys/documents/Indicator-Descriptions.pdf

World Bank Group. “GDP (current US$).” Retrieved from https://data.worldbank.org/indicator/NY.GDP.MKTP.CD

World Bank Group. “GDP deflator-United States.” Retrieved from https://data.worldbank.org/indicator/NY.GDP.DEFL.ZS?locations=US

World Bank Group. “Sampling Note.” 2009. Retrieved from https://www.enterprisesurveys.org/content/dam/enterprisesurveys/documents/methodology/Sampling_Note.pdf

World Bank Group. “Stronger Open Trade Policies Enable Economic Growth for All.” 2018. Retrieved from https://www.worldbank.org/en/results/2018/04/03/stronger-open-trade-policies-enables-economic-growth-for-all

World Bank Group. “Trade (% of GDP).” 2021. Retrieved from https://data.worldbank.org/indicator/NE.TRD.GNFS.ZS

Van Biesebroeck, Johannes. "Exporting raises productivity in sub-Saharan African manufacturing firms." *Journal of International Economics* 67, no. 2 (2005): 373-391.

Appendix

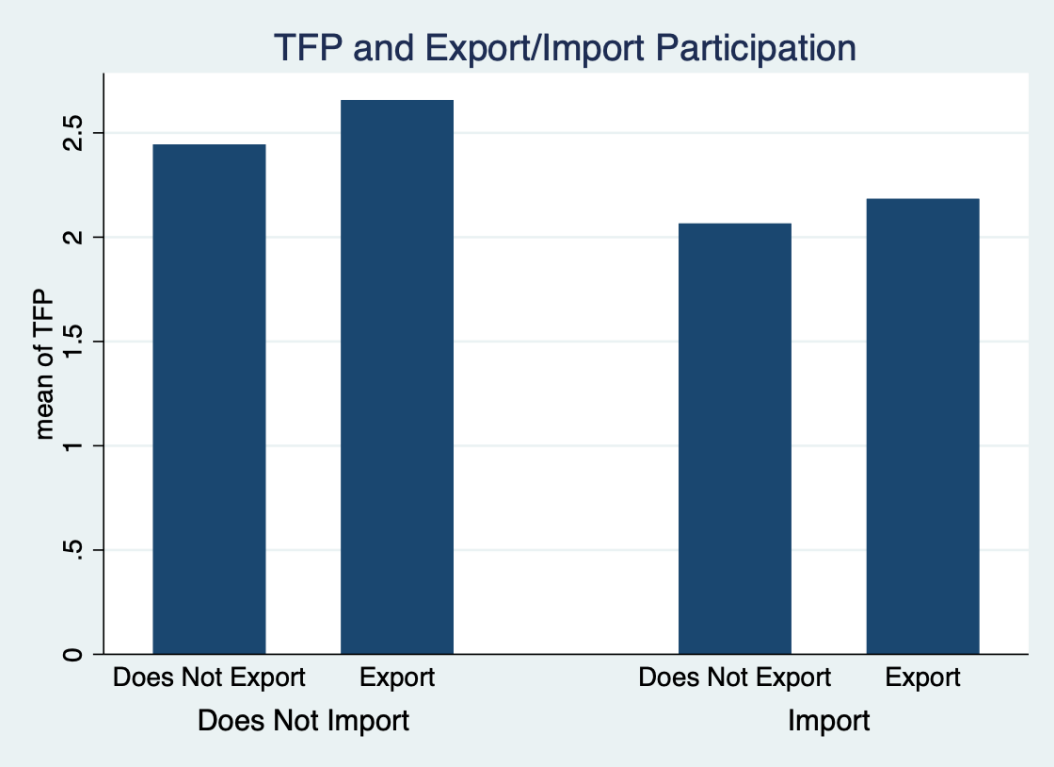

Figure 1: TFP and Export/Import Participation.

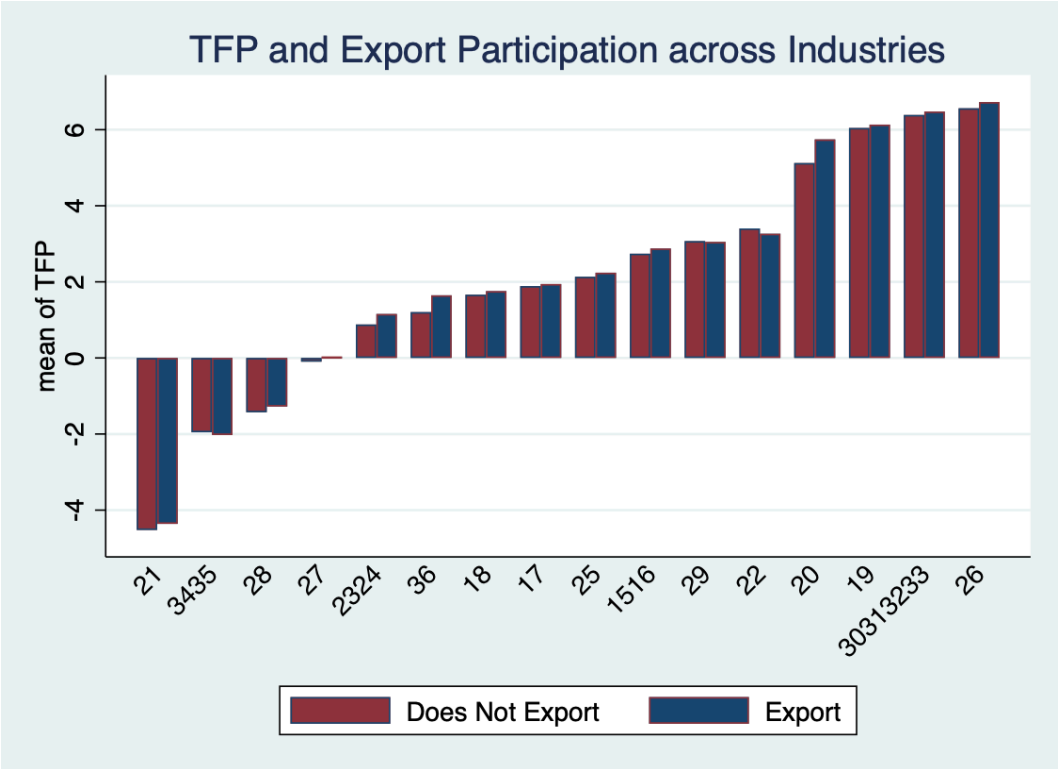

Figure 2: TFP and Export Participation across Industries.

Note: On the x-axis, the numbers are ISIC code numbers. The codes on the x-axis identify the industry with two digits, and several are classified into more than one industry and therefore have more than two digits. Same for Figure 3.

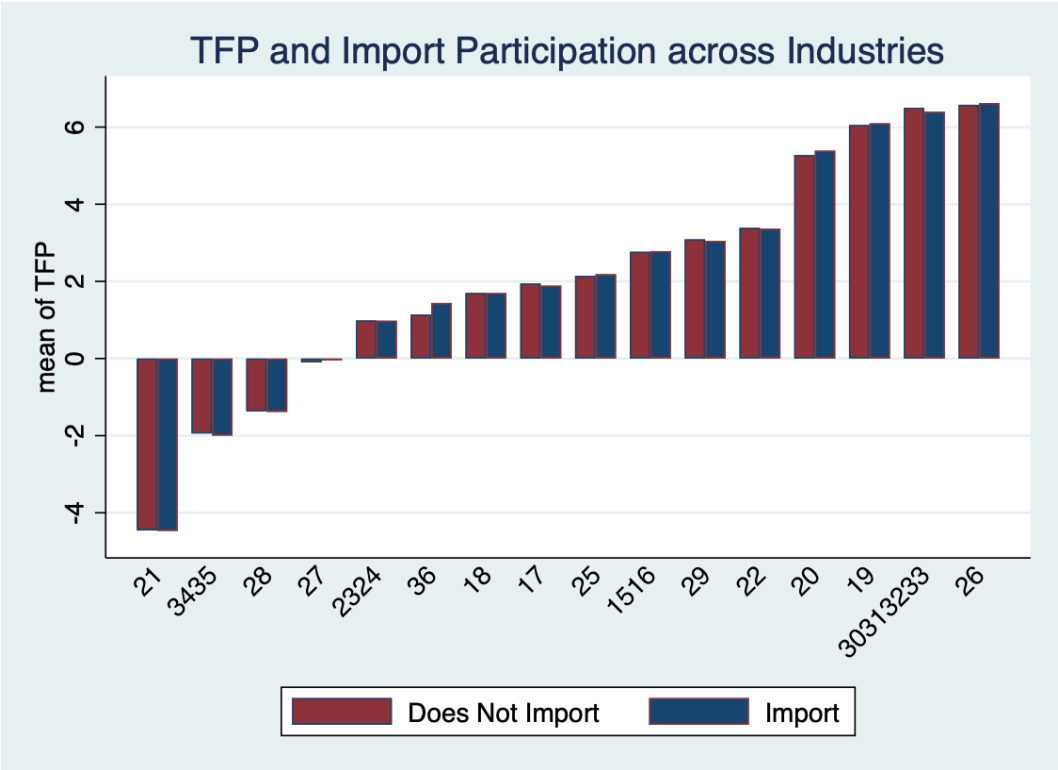

Figure 3: TFP and Import Participation across Industries.

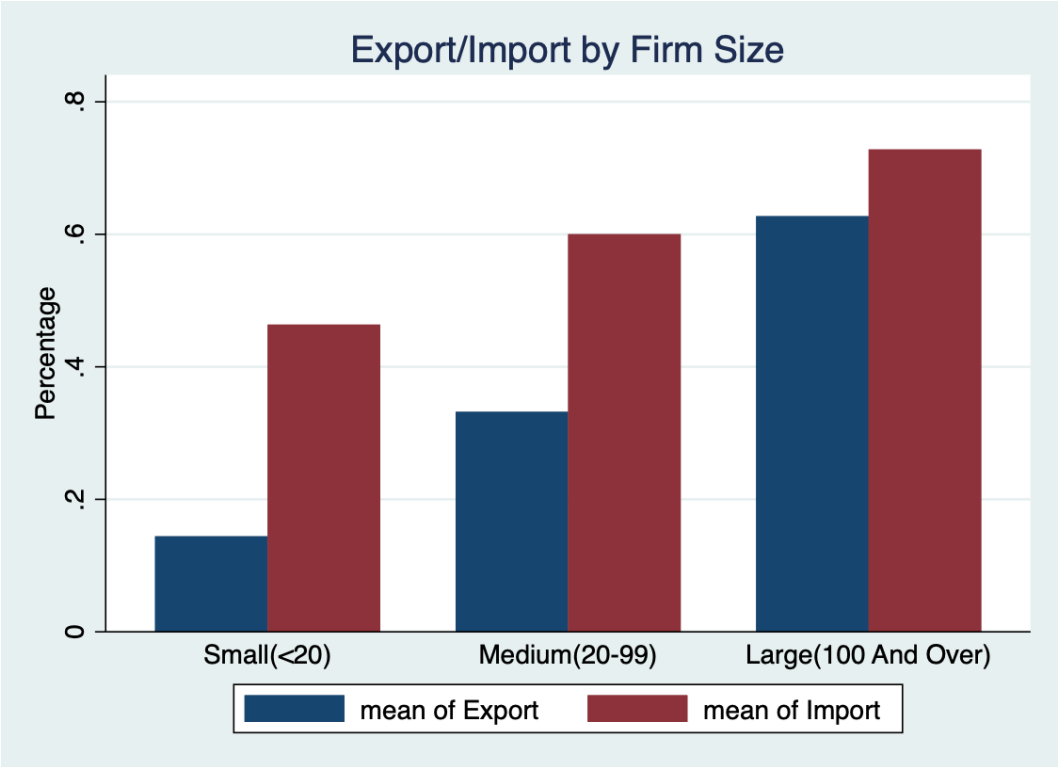

Figure 4: Export/Import by Firm Size.

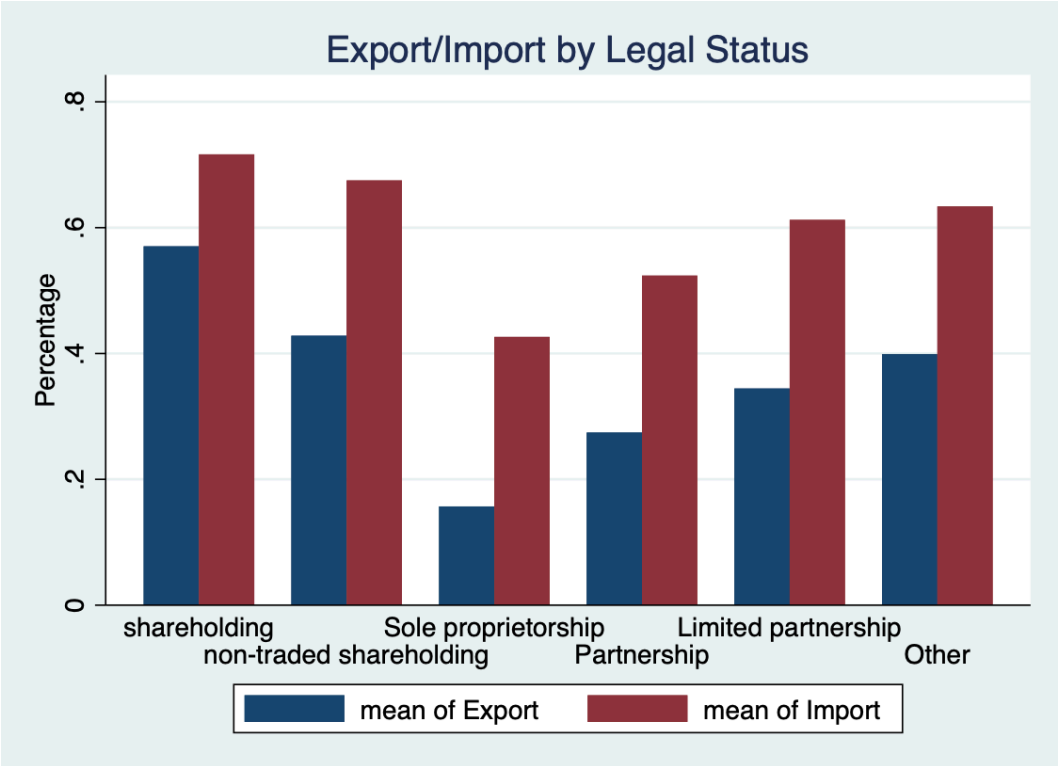

Figure 5: Export/Import by Legal Status.

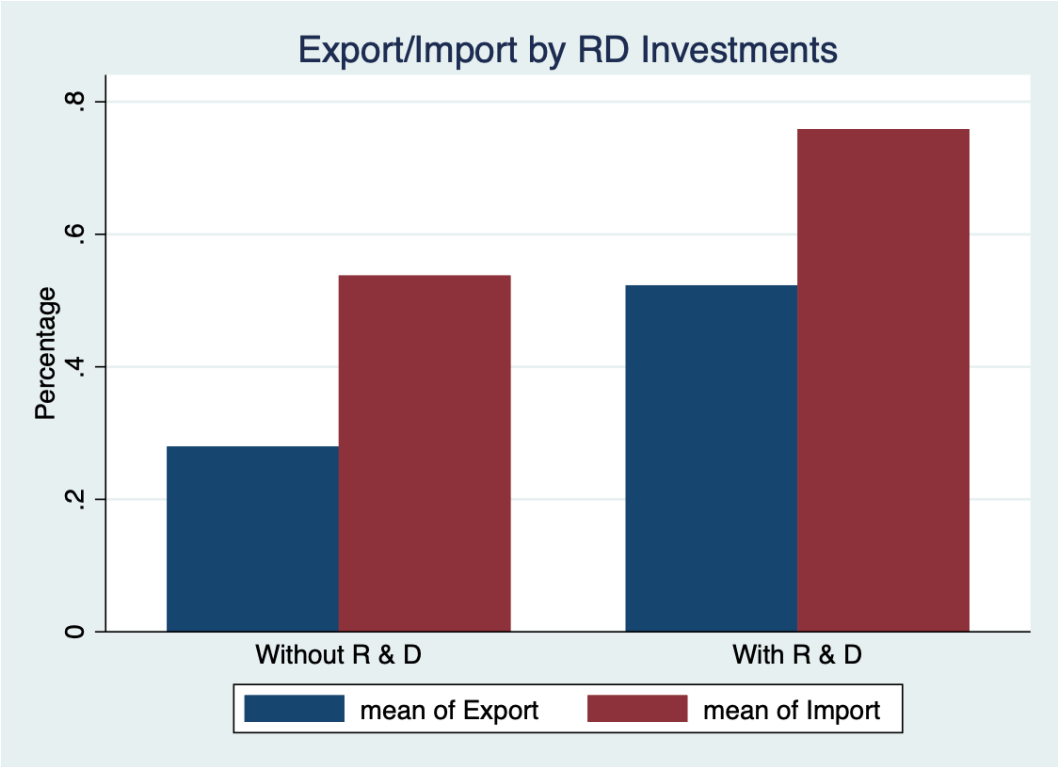

Figure 6: Export/Import by RD Investments.

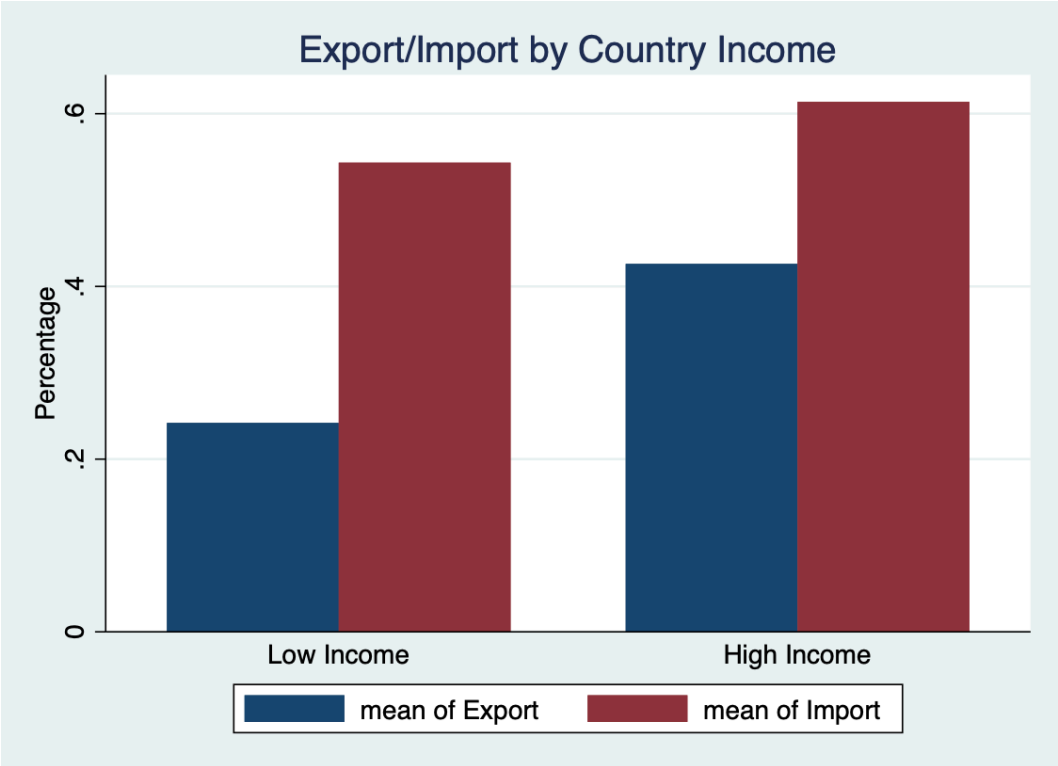

Figure 7: Export/Import by Country Income.