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Credit Constraint and Global Value Chain Participation

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Abstract

Credit constraints could impose important barriers against firm's value added exports. Theoretically, my model which incorporates borrowing constraint into exporting firm's profit maximization problem predicts credit constraints reduces firm export and export intensity. Using data on 66 economies from 1995-2018, I find evidence that the effect of credit constraint vary across industries that have differing levels of external financing and asset tangibility. For exporting countries with more developed financial systems, industries that rely more heavily on external financing experience larger boosts in exports. On the other hand, financially less developed countries export less in industries with fewer collateralizable assets. The effect is more ambiguous when examining export intensity. Overall, I provide evidence that credit constraint constitutes a significant barrier for global value chain participation.

1 Introduction

Global value chain (GVC) is the international fragmentation of production tasks where each fragmented production process is located across different countries. In the pursuit of maximum efficiency, firms optimize their production processes by organizing the different stages of production across different sites. (WorldBank 2020). Financial development, and industries' idiosyncratic financial conditions due to the their inherently different production process could have important effects on GVC participation. Fernandes et al. (2020) found significant positive correlations between a list of country-level variables (e.g. trade agreement, distance between countries, factor endowment, institution quality) and a country's GVC participation. In this paper, I further explore industry-level determinants of GVC participations, and explore credit constraint as a potential source of cross-industry variation in GVC participation. My paper shows that financially more vulnerable sectors in more financially developed countries have comparative advantages in value added exports, compared to financially less vulnerable sectors. In particular, firms in industries with heavier reliance on external financing export more in value added in countries with more developed financial systems, and firms in industries with fewer collateralizable assets export less when situated in finacnailly less developed countries.

My paper connects closely to the streamline of literature which focuses on the interaction between credit constraint, financial development, and international trade. Past literature argued that credit constraint may serve as a source of comparative advantage for firms in financially developed countries in exports, particularly in industries that require more upfront costs for trade. Manova (2008) argued that equity market liberalization promotes export disproportionately more in financially vulnerable sectors with a reduced form estimation. A sector is more financially vulnerable if the credit condition of a firm is more salient in that sector. Formalizing the idea by incorporating credit constraint into a heterogeneous firm model, Manova (2013) argued that financially developed countries export more in financially vulnerable sectors by entering more markets, shipping more products and selling more products. Modeling from bank's perspective, Feenstra et al. (2014) argued that banks lends below the amount required for firm's optimal production to maintain incentive compatibility, and such credit constraints were more stringent for exporters due to longer shipment time. Highlighting the importance of financial development in these interactions, Eichengreen et al. (2011) found that financial liberalization has positive effects on growth of financially dependent industries, and such effects are limited to countries with relatively well-developed financial systems. This line of literature recognizes the two main risks in firm's decision of exporting. The first risk is associated with huge upfront sunk cost to pay, which are incurred due to reasons such as upfront investment required to enter foreign markets, or to produce customized input. The second risk lies in the longer time lag between production and receipt of sales revenue. Firms with better credit conditions, and backed by a more developed financial system therefore may have comparative advantage in exporting.

However, an important shortcoming with the empirical analysis in existing literature lies in the use of gross export instead of value added export partly due to data availability. Due to the problems of "double-counting" and multi-country production network, gross export significantly overstates the value added transaction across borders. (Johnson and Noguera 2012) The "double-counting" problem stems from the fact that conventional gross trade simply sums up value of goods at each crossing of border, rather than measuring the net value added between borders. The multiple-country production network recognizes that intermediate goods could travel to final destination via an indirect route. Conceptually, gross export could be decomposed into more components than domestic value added content exported abroad, such as foreign value added. (Antras and Chor Forthcoming) However, in the structural model, firms effectively observes profit in value added terms. This measurement error at the aggregate level using gross export instead of value added export could therefore lead the existing literature to underestimate the effect of credit constraint on firm exports.

My paper contributes to the literature by bridging the two lines of literature, and examining the effect of credit constraint on export using value added trade flows. Using detailed Chinese firm level data, Manova and Yu (2016) found that higher upfront cost prevents firm from participating in higher value added activities. In this paper, I analyze the question using aggregate data and examine if the same mechanism holds at a larger cross-country scale.

Heavily referencing from Kohn et al. (2016), my model predicts that credit constraint has negative impact on both export value and export intensity. My empirical model further explores the interaction between financial development and industry finance vulnerabilities, constructed following Rajan and Zingales (1998) and Beck (2003). I employ a difference-in-differences design similar to other studies (Rajan and Zingales (1998), Manova (2008), Manova (2013)) to estimate the interaction effects. I find that credit constraints do have significant impacts on value added export, and financial development could help mitigate their negative effects. My empirical findings are mostly in aligned with my model prediction and empirical hypothesis.

GVC participation is an important topic as past research has shown that it enhances productivity growth. Focusing on domestic value added in exports, Pahl and Timmer (2020) found that GVC participation has long-run positive effects on the productivity growth, particularly in the formal manufacturing sector. The capability of exporting products of higher quality and complexity is an important indication of economic growth and development. Ndubuisi and Owusu (2021) argued that GVC participation impacts positively on the quality of exported products and improves the quality level to one that is closer to the quality frontier. Using a detailed firm-level dataset from Estonia, Banh et al. (2020) found that GVC participation at the industry level significantly boosted productivity at both the industry and the firm level. My results on the interaction of credit constraint and GVC participation therefore provide a potential linkage through which a country's credit condition and financial system could impact its productivity growth.

The remaining paper is structured as follows. Section 2 provides theoretical guidance to my question. Section 3 presents my baseline estimation strategy. Section 4 describes the data. Section 5 presents my main results and findings, along with robustness checks. Section 6 concludes.

2 Model

In this section, I present a model with fixed and sunk costs of exporting, with credit constraints. This model is drawn from Kohn et al. (2016) and applied in the context of global value chain and credit constraint.

2.1 Environment

The model features an economy in which a continuum of monopolistically competitive firms each produces a differentiated good and is owned by one entrepreneur. Firms and entrepreneurs are used interchangeably below. Firms have access to assets with an exogenously given constant return rate of r.

Firms choose how much to produce in domestic market, and whether to enter the export market. If firms enter the export market, they also choose how much to produce and sell in the export market. For simplicity, in this model real wage ω, interest rates r, and demand schedules are exogenously determined in both domestic and foreign market. To enter the export market, firms would have to pay a one-time sunk cost S to enter the export market.

To remain in the export market, firms would have to pay per-period fixed cost F. Both costs are measured in units of labor. In addition, exporting firms face iceberg costs τ as in the standard trade literature.

Formally, the exogenous demand schedules with constant elasticity of substitution (CES) are:

$$q_i = (\frac{p_i}{P})^{-\sigma} Q, \;\; q_{i^*} = (\frac{p_i^*}{P^*})^{-\sigma} Q^*$$

where p_i and q_i are price and volume of product in domestic market produced by firm i, and P and Q are aggregate price level and aggregate demand in domestic market. p_i^*, q_i^*, P^*, Q^* are corresponding price and quantity levels in the foreign market. σ denotes the elasticity of substitution between goods in domestic and foreign markets. [1]

In this model, firm i produces goods with a constant returns to scale production technology, and only takes in one input only (labor). The production of firm i is:

$$y_i = z_i N_i$$

where z_i is the idiosyncratic productivity of firm i, and N_i is the total labor (both domestic and foreign) employed by firm i.

In this model, firm i faces credit constraints as it needs to pay upfront cost in production and exporting. Assume that firms have to pay a portion of labor cost for domestic production upfront (with the proportion denoted by $\alpha \in [0, 1]$), and pay all the costs related to exporting upfront. Firms pay this upfront cost with its own asset a, and external borrowing. Assume no interest needed to be paid for intra-period borrowing, and that firms could at most borrow up to $\lambda - 1 \geq 0$ of their assets, the maximum liquidity that firm i has at any period is λa. Formally, the credit constraint the firm faces is:

$$\lambda a \geq \alpha \omega n + e'[\omega n^* + \omega F + (1 - e)\omega S]$$

where n and n^* denote the number of labor employed for domestic and foreign market, e' denotes export status this period, and e denotes export status last period.

[1] The implicit assumption is $\sigma > 1$. See Appendix A.3 for more discussion.

2.2 Solution to Repeated Static Problem

In the model, firms maximize their profits at each period, subjected to their credit constraints. Their profits consist of both domestic profit and export profit, but entering export market for higher profit incurs more cost and requires more payment in advance. Such static problem of firm profit maximization is formally written as:

$$
\begin{aligned}
\Pi(a,z,e',e) = &\max_{n,n^*,q,q^*} pq - \omega n + e'[p^*q^* - \omega n^* - \omega F - (1-e)\omega S] \\
\text{s.t. } & n = \frac{q}{z} \\
& n^* = \frac{\tau q^*}{z} \\
& q = (\frac{p}{P})^{-\sigma} Q \\
& q^* = (\frac{p^*}{P^*})^{-\sigma} Q^* \\
& \lambda a \geq \alpha\omega n + e'[\omega n^* + \omega F + (1-e)\omega S]
\end{aligned}
$$

To examine the effect of credit constraints on value added exports, I focus my discussion on exporting firms only ($e' = 1, e = 1$). To study the effect of credit constraint, I posit that credit constraint binds. To describe a more realistic scenario where firms tend not to pay all of its cost associated with domestic production in advance, I focus my discussion on the scenario of $\alpha < 1$.

Definition 1. *Consider a credit constrained exporter ($\mu > 0$).* [2] $\hat{q}, \hat{q}^*$ *denote the optimal quantities exporter i chooses to produce for domestic and foreign market. They are derived as the solution to the static problem.* $\hat{p}, \hat{p}^*$ *are the corresponding prices.*

(1a) *The export revenue of exporter i is:*

$$\hat{p}^*\hat{q}^* = (P^*)^\sigma Q^* [\frac{\sigma}{\sigma-1}\frac{\omega\tau(1+\mu)}{z}]^{1-\sigma} \tag{1a}$$

(1b) *The export intensity of exporter i is:*

$$\text{EI} \equiv \frac{\hat{p}^*\hat{q}^*}{\hat{p}^*\hat{q}^* + \hat{p}\hat{q}} = \frac{(P^*)^\sigma Q^*[\tau(1+\mu)]^{1-\sigma}}{(P^*)^\sigma Q^*[\tau(1+\mu)]^{1-\sigma} + P^\sigma Q[1+\alpha\mu]^{1-\sigma}} \tag{1b}$$

[2] μ is the Lagrangian multiplier on credit constraint in profit maximization problem. See Appendix A.3 for more details.

Proof. *See Appendix A.3*

Credit constraint μ enters both domestic output and export because firms when credit constraint binds. Specifically, the impact of credit constraint on both measures of export is given by the proposition below:

Proposition 1. *Credit constraint negatively impacts both export revenue and export intensity.*

(2a) *Exporter export revenue decreases as borrowing constraint tightens.*

$$\frac{\partial \hat{p}^* \hat{q}^*}{\partial \mu} < 0 \tag{2a}$$

(2b) *Exporter export intensity also decreases as borrowing constraint tightens.*

$$\frac{\partial EI}{\partial \mu} < 0 \tag{2b}$$

Proof. *See Appendix A.3*

Intuitively, when credit constraint binds, firms are forced to produce below their optimal level, as they do not have enough levels of asset to reach optimal production level. Credit constraint binds also imply that the production for domestic and foreign market becomes interdependent, as increase in production for one market necessarily reduces production for the other market.

3 Empirical Strategy

3.1 Estimation of Financial Vulnerabilities

My baseline empirical approach posits that, due to inherent technological nature of production, different industries have varying degrees of dependence on external finance (efd), as opposed to internal finance, defined as the cash flow generated from firm operations. Industries also have varying degrees of asset tangibility (at), which further accounts for investor behavior in an environment of poor financial contractibility. Specifically, efd describes the extent to which the median firm of an industry relies on capital external to the firm and *at* describes the proportion of hard assets in total book-value assets for the median firm of an industry, an approximation for the strength of collateral and assurance for financiers. Following Rajan and Zingales (1998) and Beck (2003), the two financial vulnerability measures are calculated in the following ways:

$$\text{efd} = \text{median}(\frac{\text{K expenditure} - \text{Cash Flow from Operation}}{\text{K expenditure}}) \tag{3}$$

$$\text{at} = \text{median}(\frac{\text{Net Property, Plant \& Equipment}}{\text{Total Assets}}) \tag{4}$$

A critical assumption is that industries have the same financial vulnerabilities across countries in the world. This implies that parameters in credit constraint (λ, α, F, S) do not vary across countries. Section 4 further discusses the details for construction.

3.2 Connection to Model

Similar to Manova (2013), I assume a specific empirical form of credit constraint such that it could be expressed as a function of observed country measures of financial development (*FD*), and sectoral indicators of external finance dependence (*efd*) and asset tangibility (*at*). The relationship between credit constraint and aforementioned observable measures could be modelled as:

$$\begin{aligned} \mu \propto & f(\text{FD} \times \text{efd}, \text{FD} \times \text{at}) \\ \text{s.t. } & \frac{\partial \mu}{\partial(\text{FD} \times \text{efd})} < 0 \\ & \frac{\partial \mu}{\partial(\text{FD} \times \text{at})} > 0 \end{aligned} \tag{5}$$

Recall μ represents the marginal value of relaxing the credit constraint. Firms with lower level on external borrowing in less developed financial system have higher marginal value of additional unit of credit than firms with higher level of external borrowing in more developed countries. Additional external funding could bring more profit to firms with lower credit amount since they might be more credit constrained before and couldn't make additional investments. Hence, the correlation between μ and interaction of *FD* and *efd* is expected to be negative. Conversely, for firms have same levels of collateralizable assets, they are more likely to convert additional asset into profit, and hence the expected sign on

μ and interaction of FD and at is positive.

The functional assumption on credit constraint directly imply the direction of interactive effects between industry financial vulnerabilities and export value and intensity. Firms that rely more on external financing would export more in value added when backed with more developed financial system. Firms with larger proportion of collateralizable assets are less exposed to the boosting effect.

$$\frac{\partial \hat{p}^* \hat{q}^*}{\partial (\text{FD} \times \text{efd})} > 0, \ \frac{\partial EI}{\partial (\text{FD} \times \text{efd})} > 0 \tag{6a}$$

$$\frac{\partial \hat{p}^* \hat{q}^*}{\partial (\text{FD} \times \text{at})} < 0, \ \frac{\partial EI}{\partial (\text{FD} \times \text{at})} < 0 \tag{6b}$$

Proof. Combining Proposition 1 (equations 2a, 2b) and relationship between credit constraint and observable measures (equation 5):

$$\frac{\partial \hat{p}^* \hat{q}^*}{\partial (\text{FD} \times \text{efd})} = \frac{\partial \hat{p}^* \hat{q}^*}{\partial \mu} \frac{\partial \mu}{\partial (\text{FD} \times \text{efd})} > 0, \ \frac{\partial EI}{\partial (\text{FD} \times \text{efd})} > 0 \text{ similarly}$$

$$\frac{\partial \hat{p}^* \hat{q}^*}{\partial (\text{FD} \times \text{at})} = \frac{\partial \hat{p}^* \hat{q}^*}{\partial \mu} \frac{\partial \mu}{\partial (\text{FD} \times \text{at})} < 0, \ \frac{\partial EI}{\partial (\text{FD} \times \text{at})} < 0 \text{ similarly}$$

Equations 6a and 6b provide the basis of my hypothesis on the dynamics between financial development and value added trade. I hypothesize that for the exporting, (1) industries that rely more on external financing would export more in value added when backed with more developed financial system, and (2) industries with higher asset tangibility are less exposed to these effects. In other words, the effects of financial development are stronger on industries that have higher levels of financial vulnerability.

Figure 1 provides suggestive evidence to support my hypothesis. In Figure 1a, the slope is positive for more financially developed countries and negative for their counterparts, indicating increasing value added share in industries with higher *efd* for more financially developed countries. In Figure 1b, the slope is negative for more financially developed countries and positive for their counterparts, indicating the importance of asset tangibility in shielding against credit constraint.

3.3 Estimation Strategy

My hypothesis can be more formally tested by estimating a differences-in-differences regression in which the effect of financial development on value added export varies with the level of financial vulnerability. Inspired by Rajan and Zingales (1998) and Manova (2013), the estimation equation underlying the baseline specification is:

$$Y_{ijst} = \alpha Z_{ij} + \beta X_{it} + \gamma_1 \mathrm{FD}_{jt} \times \mathrm{efd}_s + \gamma_2 \mathrm{FD}_{jt} \times \mathrm{at}_s + \delta_j \times \delta_t + \delta_i \times \delta_s + \epsilon_{ijst} \tag{7}$$

where i denotes importer, j denotes exporter, s denotes sector, and t denotes year. Y_{ijst} is a measure of sectoral value added export (e.g. $\log \mathrm{DVA}/\mathrm{GX}$ where DVA represents domestic value added in export and GX represents gross export) between importer i and exporter j. *efd* and *at* are two measures of financial vulnerability, external finance dependence and asset tangibility. *FD* measures a country's financial development. X_{jnt} and M_{int} are vectors of country and industry controls for exporter j and importer i respectively at time t.[3] Z_{ij} is a vector of gravity model variables between the trading partners.[4] The use of exporter $\times$ time (δ_{it}) and importer $\times$ industry (δ_{jn}) fixed effects help mitigate endogeneity problems.[5] Following standard trade literature, I cluster the standard errors in all our specifications on country pair-year since outcomes are in country-sector-time level, and country-sector outcome are likely to be persistent over time. [6]

The main coefficients of interest are γ_1 and γ_2. γ_1 and γ_2 captures the differential impacts of financial development of the exporting countries on value added export across industries with varying external finance dependence and asset tangibility respectively. If financial development facilitates value added export in a fashion consistent with my hypothesis , where firms more reliant on external finance could export more due to lowered credit constraint, and firms do not require as much hard asset as collateral for borrowing, then I expect γ_1 to be positive and γ_2 to be negative. In other words, γ_1 and γ_2 should reflect the relationships between export and observable measures of credit constraint as in equations 6a and 6b.

However, I recognize that the two coefficients could also reflect differences inherent in production process across countries. The estimation assumes that production processes

[3] Control variables include: capital-labor ratio, human capital index, real output GDP, real effective exchange rate, tariffs, and GATT/WTO affiliation.

[4] Z_{ij} (gravity variables): contiguity, distance, common language, former colony, common currency, common religion, sibling relationship

[5] These fixed effect choices follow from Chor (2010).

[6] I also cluster standard errors by country pair only. The results in section 5 do not have qualitative changes in terms of statistical significance.

within the same industry across countries are essentially the same. This is an extremely strong assumption, and I acknowledge that any bias stemmed from such source could not be mitigated in my estimation. For example, Ciccone and Papaioannou (2016) argue estimates based on this assumption could generate both attenuation and amplification biases depending on the similarity in both technological production and other covariates between sample countries and benchmark country (US). Such biases are not addressed in my estimation method.

I argue that this specification could help mitigate reverse causality in estimation. As empirically observed, there exists little cross-sector variation in financial development, and hence it is most likely the impact from the interaction terms (γ_1, γ_2) describes the impact of credit constraint on value added trade only. In addition, following (Manova 2013), I also argue that both interaction terms would need to be statistically significant for the full story. In a perfect financial market, γ_1 would be positive and significant regardless, but I would expect the effect of collateral to be insignificant since firms should be able to borrow freely. The statistical significance of *at* interaction term is further required to strengthen the story regarding the effect of credit constraint.

Recognizing the inconsistency in estimating gravity equations in additive form by OLS in the presence of heteroscedasticity (Silva and Tenreyro 2006), I decided to use Poisson Pseudo Maximum Likelihood (PPML) estimator for my analysis. Silva and Tenreyro (2011) further confirm that PPML estimator is well-behaved in general even when proportion of zeros in the sample is very large. To perform the analysis, I used the package provided by Correia et al. (2020).

To ensure that my data is compatible with previous literature, I also conducted a regression analysis very similar to the one in Manova (2013) as robustness check. The results of this replication is shown in Appendix A.1.

4 Data

My data consist of four main parts: value added trade, measures of industry financial vulnerability, measures of financial development and additional control variables.

Value Added Trade

I obtain annual value added export data at current prices from the OECD Trade in Value Added (TiVA) database. (OECD 2021). This database provides value-added export data, processed from OECD's Inter-Country Input-Output tables, for 66 economies including all OECD, EU28 and G20 countries, most East and South-east Asian economies and a selection of South American countries. The dataset covers the period from 1995 to 2018, and offers trade data for 17 unique manufacturing sectors, which are defined base on two-digit level of International Standard Industrial Classification (ISIC) Revision 4. To adjust for the potential price effects from inflation, I normalize trade value to 2017 constant US dollars using export price index from Penn World Table 10.0. (Feenstra et al. 2015)

Industry Financial Vulnerability

I obtain external finance dependence and asset tangibility measures based on the North American Compustat and Global Compustat data, which spans the time period from 1995 to 2015. I crosswalked the industry concordance from SIC to ISIC Rev.4. Following Rajan and Zingales (1998) and Beck (2003), I calculated the two measures in accordance with equation 3 and 4. [7] Both measures are based on data on US-headquartered firms and are averaged over the period of 1995-2015. I focus on these two particular measures of industry financial vulnerability because the upfront costs for exporting costs are typically financed by external capital, which were obtained with collateral in the form of tangible assets.

Manova (2013) argues that external finance dependence is an appropriate proxy that captures much expenditures of exporting firms for international trade. The underlying data from Compustat are mainly based on large US exporters, further suggesting that external finance is more likely related to international trade as opposed to domestic activities. While both external finance dependence and asset tangibility measures are constructed using US company data, Rajan and Zingales (1998) and Beck (2003) argue that their respective measures capture a large technological component innate to the manufacturing process in a sector and are good proxies for ranking industries across all countries in terms of their financial vulnerabilities. They further argue that the US data in particular could better reflect a

[7] I first sum the fields capital expenditures (capx), net property plant & equipment (ppent), total assets (at), and cashflow from operations from 1995-2015 by firm. Cashflow from operations is defined as the sum of funds from operations, decreases in inventories (invch), decreases in accounts receivable (recch), and increases in accounts payable (apalch in NA Compustat or apch in Global Compustat). For more detailed accounts of calculating funds from operations, see the appendix in Choi (2019).

firm's optimal choice over external financing and asset structure, given the highly developed US financial system.[8]

Financial Development

I obtain my main measure of financial development data from Svirydzenka (2016). This database constructs and classifies financial development indices for 180 countries for the period 1980-2016. The main feature of this database is that it attempts to take into account the complex multidimensional nature of financial development, instead of relying on few traditional measures of financial depth, such as private credit to GDP ratio and stock market capitalization to GDP ratio. This dataset summarizes the overall financial development of a country by the depth, access, and efficiency of the country's financial institution and financial market development.

To supplement the analysis, I also obtain traditional de facto measures of financial development (credit to private sector as percentage of GDP, stock market capitalization as percentage of GDP) from World Development Indicators (WDI) database of the World Bank as robustness check.

Country Variables

I include essential control variables that literature believe have profound effects on countries' bilateral trade. I control for a country's economic size with its real output GDP level taken from the Penn World Table 10.0. (Feenstra et al. 2015) I also use Penn World Table to obtain information on a country's capital stock, physical capital, human capital, engaged population, and employment to control for a country's factor endowments. To account for a country's production capabilities and comparative advantage in global trade, I construct measures of country capital-labor ratio. [9] To capture the effects of trade barriers, I include yearly tariff data from WDI, a simple average of tariff rates across all manufactured products. To control for the effect of exchange rate fluctuation, I use real effective exchange rate (REER) data from Darvas (2021). I also supplement an alternative measure from WDI. For my gravity model specification, I include standard gravity model variables from CEPII.

[8]The industrial measures are time-invariant over the period of interest to smooth fluctuations over time and reduce the effects of outliers.

[9]I define the capital-labor ratio as the capital stock divided by engaged person. Capital stock reflects the prices for structures and equipment within the countries and engaged person is defined as employees or self-employed.

(Head et al. 2010)

4.1 Summary Statistics

In my empirical analysis, I primarily look at 1,750,320 annual export trade entries that span 17 industries and 66 exporting and importing countries from 1995 to 2018. Each trade entry contains a full set of country observables for both the exporting and importing countries. Table 1 presents the summary statistics of the variables in the dataset, where each unit of observation is at the exporter-importer-industry-time level.

5 Results

Table 2 reports the baseline results from equation 7. Column 1 - 3 examine the dynamics by looking at log of domestic value added. The main coefficient of interest are those on the interaction terms involving exporter financial development and industry financial vulnerabilities, which correspond to γ_1 and γ_2 in equation 7. The two coefficients capture the differential impact of exporter financial development on industries of varying financial vulnerabilities. Examining the interactive effect on the industry financial vulnerability measures both independently and jointly, I find strong evidence that support my hypothesis and proposition (2a). The estimated coefficients on interaction of exporter financial development and external finance dependence (γ_1) are positive and significant at 1 percent level consistently in Column 1 and 3. This result provides evidence that the export value of a more external financing dependent industry is positively impacted by higher financial development in the exporting country. Similarly, the estimated coefficients on interaction with asset tangibility (γ_2) are negative and significant at 1 percent level consistently in Column 2 and 3. This provides evidence that financially less developed countries export less value added in sectors with fewer tangible assets. These observations are consistent with my model prediction (equation 2a) and my hypothesis on the relationship between credit constraint and export value laid out in equations 6a and 6b.

Column 4 - 6 focus on the examination of value added export intensity. The dependent variable (export intensity) was transformed to ensure that it is compatible with the PPML estimator. [10] Examining the effect of the two financial vulnerability measures separately, column 4 and 5 provide the evidence that supports my model prediction (equation 2b) and

[10]High dimensional fixed effect PPML package by Correia et al. (2020) requires positive dependent variable.

my empirical hypothesis (equations 6a and 6b). The estimated coefficient on *efd* (γ_1) is positive and significant at 1 percent level consistently in column 4. The estimated coefficient on *at* (γ_2) is positive and significant at 1 percent level consistently in column 5. However, examining the effects of both industry financial vulnerability measures together yields a different result, as shown in Column 6. The interactive effect between external finance dependence and exporter financial development seem to be reversed, while the effect between asset tangibility and financial development remains robust.

However, it is also worthwhile to note that the magnitude of coefficient γ_1 is an order of magnitude smaller than that of γ_2. The baseline result seems to suggest that the interacting effect between financial development and asset tangibility seems to be dominant in firm's exporting. This effect is consistent with the literature that less stringent credit conditions are more advantageous for industries with weaker collateral (Eichengreen, Gullapalli and Panizza 2011; Manova 2013; Manova and Yu 2016) Overall, the baseline estimates provide strong support that credit constraints affect value added export significantly.

I calculate the differentials in domestic value added share, in order to gauge the economic significance of the statistically significant coefficients, following the methodology from Rajan and Zingales (1998). Consider two industries at the 25th and 75th percentiles in terms of asset tangibilty, and two countries at the 25th and 75th percentiles in terms of exporter financial development. I compare the differentials in domestic value added share of the two industries across two countries. Using the baseline result from Column 6 in table 2, the estimated coefficient of -0.806 implies that the difference in domestic value added share between two industries is roughly 9% more negative in a country with more developed financial system compared a country with less developed financial system. [11] This interactive effect is consistent with my model prediction (equation 2b) and my empirical hypothesis (equation 6b).

It is also interesting to note the impact of interactive effect of financial vulnerability measures with importing country's financial development. It is plausible that firm borrow in the importing country too. However, the point estimates do not provide a consistent pattern. Therefore, I cannot conclude any finding from the importer side.

[11] I arrive at this value by doing the following back of the envelope calculation: $-0.806 * (FD_{p75} * at_{p75} - FD_{p25} * at_{p25})$. So, $-0.806 * (0.69 * 0.25 - 0.33 * 0.16) = -0.096$

5.1 Robustness Check

I conduct a series of robustness checks for the baseline results. First, I check against a different set of fixed effects, which was adopted in Manova (2013). Second, I check the robustness to alternative measures of financial development. Finally, I check the robustness to alternative construction of financial vulnerability measures.

In addition, I also estimated equation 7 using OLS estimator. The results are recorded in section A.2.

Alternative set of fixed effects

Table 3 shows the result of changing the fixed effect to exporter, importer, industry, time fixed effects, as adopted in Manova (2013). The main message remains the same, with a slight reduction in the magnitude of the coefficients of the interaction variables of interest.

Alternative measures of financial development

Table 4 reports the results using alternative measures of financial development. FM and FI indicators both come from Svirydzenka (2016), and refer to as financial market and financial institution respectively. Both describe important parts of financial development. Financial market index measures the depth, access, and efficiency of stock and bond markets, while financial institution index measures the same criteria for banks, insurance companies, mutual funds and pension funds. [12] In addition, I include two traditional measures of financial development used in literature, private credit as percentage of GDP, and stock market capitalization as percentage of GDP in the analysis. As shown in table 4, changing measures of financial development does not significantly change the story, as both the signs and significance levels of coefficients of interest remain the same for FM, FI, and private credit. While the signs flip using stock market capitalization, the magnitude of the coefficient is very close to zero. Considering that only a very small proportion of the exporters is listed in stock market, stock market capitalization may not properly represent the type of financial development that influences exporters, particularly in financially less developed countries. Therefore, changes in stock market capitalization do not seem to affect most exporters, as evidenced by the minuscule magnitude of coefficients. Overall, my finding is robust to the

[12] According to Svirydzenka (2016), depth measures "size and liquidity of markets", access measures "ability of companies to access financial services", and efficiency measures "ability of institutions to provide financial services at low cost with sustainable revenues, and the level of activity of capital markets"

choice of measures of financial development.

Alternative construction of industry financial vulnerability measures

Table 5 reports the results using alternative construction of industry financial vulnerability, where I constructed the same efd and at using Compustat data from sub-periods only. Since both measures are supposed to capture the inherent technological nature of production, and this alternative measures aim to capture if the advancement in technology affect my hypothesis. As shown in table 5, alternative measures of industry financial vulnerability do not significantly change the story, as both the signs and significance levels of coefficients of interest remain the same.

6 Conclusion

This paper provides an empirical attempt to explain the interactive effects of financial development and credit constraint on value added exports. I setup a problem following closely with a model first developed by Kohn et al. (2016). The model predicted that value added export and export intensity are negatively impacted by credit constraints, and financial development could potentially help mitigate this negative impact. Using a panel data which spans across two decades for 17 industries and over 60 economies, I find that financial development promotes value added exports from industries with higher external finance dependence, and economies with less developed financial system export less in sectors with lower requirements fewer tangible asset. The effect is slightly more ambiguous when examining export intensity instead of export value. My results remain robust across specifications, including different choice of fixed effects, measures of financial development, measures of financial vulnerability measures. Considering the salient effects of GVC participation on productivity growth evidenced by past research, my finding points to the importance of financial development and firm credit constraint on economic development. Financial underdevelopment, or low supply of credit towards firms could both serve as significant barriers against export and productivity growth, potentially with varying effects across industries. The policy implications of the potential consequences of the findings motivate further research in the area.

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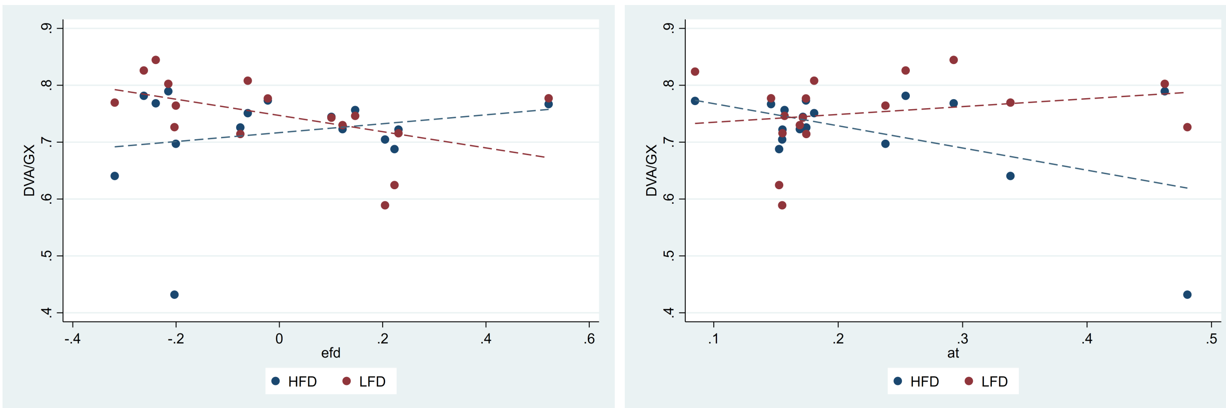
Figures and Tables

Figure 1: Domestic Value Added Share of Export across Industries by Country Financial Development



(a) External Finance Dependence

(b) Asset Tangibilty

Note: DVA = domestic value added in exports; GX = gross exports. Countries are divided into financially developed (HFD) and less financially developed (LFD) by median value of financial development in 1995. Each dot represents mean of DVA/GX across all countries of HFD/LFD across 1995-2018 by industry (17 industries). Replacing y-axis with log(DVA/GX) exhibits similar trends. Pharmaceuticals, medicinal chemical, and botanical products is taken out for figure 1a due to extremely outlier value

Table 1: Summary statistics of variables, 1995-2018

	mean	sd	min	p25	p50	p75	max	count
A. Trade								
GX (2017US$, millions)	56.26	524.70	0.00	0.05	0.83	10.05	94940.51	1750320
DVA (2017US$, millions)	39.92	373.89	0.00	0.04	0.55	6.84	69198.14	1750320
DVA/GX	0.69	0.21	0.00	0.59	0.71	0.81	1.00	1360823
B. Country level								
Human capital Index	2.88	0.55	1.43	2.55	2.97	3.30	4.15	1584
(Log) K/L	-5.56	0.89	-8.41	-6.15	-5.39	-4.92	-3.17	1488
(Log) Real GDP	12.72	1.63	8.77	11.72	12.75	13.83	16.82	1584
(Log) 1 + Tariff	0.04	0.05	0.00	0.02	0.03	0.06	0.36	1428
(Log) REER	4.59	0.16	3.83	4.52	4.59	4.67	5.46	1560
FD: Financial development index	0.50	0.22	0.04	0.33	0.49	0.69	1.00	1430
FI: Financial institutions	0.58	0.22	0.08	0.39	0.59	0.76	1.00	1430
FM: Financial markets	0.42	0.25	0.00	0.22	0.41	0.62	1.00	1430
Private Credit to GDP	0.82	0.51	0.00	0.39	0.74	1.17	3.05	1256
Stock Market Capitalization to GDP	0.78	1.22	0.00	0.26	0.49	0.90	12.75	1143
C. Industry level								
efd (1995-2015)	0.44	1.85	-0.32	-0.20	-0.02	0.20	7.58	17
at (1995-2015)	0.22	0.11	0.08	0.16	0.17	0.25	0.48	17
efd (1995-2007)	0.18	0.94	-0.30	-0.24	-0.03	0.16	3.75	17
at (1995-2007)	0.23	0.11	0.11	0.17	0.19	0.26	0.50	17
efd (2009-2015)	0.37	3.49	-0.78	-0.66	-0.42	-0.38	13.86	17
at (2009-2015)	0.19	0.11	0.06	0.13	0.14	0.22	0.46	17

Note: This table presents the summary statistics for all variables used in all specifications. GX = Gross Trade; DVA = Domestic Value Added in Exports; K/L = capital-labor ratio; REER = Real Effective Exchange Rate; efd = external finance dependence; at = asset tangibility

Table 2: Baseline

	(1) log_va	(2) log_va	(3) log_va	(4) log_sh	(5) log_sh	(6) log_sh
exporter FD × efd	0.026***		0.016***	0.009***		-0.010***
	(0.00)		(0.00)	(0.00)		(0.00)
exporter FD × at		-0.496***	-0.397***		-0.736***	-0.806***
		(0.01)	(0.01)		(0.01)	(0.01)
importer FD × efd	-0.002***		0.003***	0.007***		0.001
	(0.00)		(0.00)	(0.00)		(0.00)
importer FD × at		0.205***	0.225***		-0.278***	-0.270***
		(0.02)	(0.02)		(0.04)	(0.04)
importer FD	0.035***	-0.012**	-0.017***	-0.002	0.063***	0.060***
	(0.00)	(0.00)	(0.01)	(0.00)	(0.01)	(0.01)
FE: Ex-Time Im-Ind	Yes	Yes	Yes	Yes	Yes	Yes
N	1,002,907	1,002,907	1,002,907	1,036,870	1,036,870	1,036,870

Note: log_va = log of domestic value added (log(DVA)); log_sh = log of domestic value added share in gross exports (log(1 + DVA/GX))

Table 3: Robustness Check: Alterantive Fixed Effects

	(1) log_va	(2) log_va	(3) log_va	(4) log_sh	(5) log_sh	(6) log_sh
exporter FD	0.009**	0.123***	0.096***	-0.006	0.145***	0.162***
	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)
exporter FD × efd	0.024***		0.015***	0.008***		-0.009***
	(0.00)		(0.00)	(0.00)		(0.00)
exporter FD × at		-0.477***	-0.381***		-0.675***	-0.736***
		(0.01)	(0.01)		(0.01)	(0.01)
importer FD	0.034***	0.019***	0.022***	0.005	-0.009	-0.009
	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)
importer FD × efd	-0.003***		-0.002***	-0.002***		-0.000
	(0.00)		(0.00)	(0.00)		(0.00)
importer FD × at		0.066***	0.054***		0.062***	0.061***
		(0.01)	(0.01)		(0.01)	(0.01)
FE: Ex Im Ind Time	Yes	Yes	Yes	Yes	Yes	Yes
N	931,279	931,279	931,279	960,728	960,728	960,728

Note: log_va = log of domestic value added (log(DVA)); log_sh = log of domestic value added share in gross exports (log(1 + DVA/GX))

Table 4: Robustness Check: Alterantive Measures of Financial Development

	log_va				log_sh			
	(1) FM	(2) FI	(3) Credit	(4) Mktcap	(5) FM	(6) FI	(7) Credit	(8) Mktcap
exporter FD × efd	0.010***	0.017***	0.004***	0.000***	-0.007***	-0.011***	-0.004***	-0.001**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
exporter FD × at	-0.261***	-0.416***	-0.147***	-0.023***	-0.520***	-0.859***	-0.260***	0.018***
	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)
importer FD	-0.029***	0.036***	-0.005***	0.000	0.023***	0.089***	0.027***	0.003*
	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)
importer FD × efd	0.000	0.007***	0.002***	0.001***	0.002	-0.002	0.000	-0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
importer FD × at	0.109***	0.205***	0.050***	0.013***	-0.117***	-0.359***	-0.122***	-0.008
	(0.01)	(0.02)	(0.01)	(0.00)	(0.03)	(0.04)	(0.02)	(0.01)
FE: Ex-Time Im-Ind	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1,002,907	1,002,907	796,693	742,134	1,036,870	1,036,870	820,479	760,378

Note: Credit = Private Credit (% GDP); Mktcap = Stock Market Capitalization (% GDP)

Table 5: Robustness Check: Alterantive Measures of Industry Financial Vulnerabilities

	1995-2007			2009-2015		
	(1)	(2)	(3)	(4)	(5)	(6)
	log_va	log_va	log_va	log_sh	log_sh	log_sh
exporter FD × efd	0.016***	0.037***	0.008***	-0.010***	-0.016***	-0.005***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
exporter FD × at	-0.397***	-0.359***	-0.410***	-0.806***	-0.804***	-0.789***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
importer FD	-0.017***	-0.019***	-0.009*	0.060***	0.066***	0.056***
	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)
importer FD × efd	0.003***	0.005***	0.002***	0.001	0.001	0.001
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
importer FD × at	0.225***	0.226***	0.218***	-0.270***	-0.278***	-0.284***
	(0.02)	(0.02)	(0.02)	(0.04)	(0.04)	(0.04)
FE: Ex-Time Im-Ind	Yes	Yes	Yes	Yes	Yes	Yes
N	1,002,907	1,002,907	1,002,907	1,036,870	1,036,870	1,036,870

Note: log_va = log of domestic value added (log(DVA)); log_sh = log of domestic value added share in gross exports (log(1 + DVA/GX))

A Appendix

A.1 Replication

Table A1 shows my replication of the reduced form estimation in Manova (2013) on gross exports. The dependent variable is log of gross export. The results show the same sign as expected. The coefficients of interaction variables between external finance dependence and financial development remain positive and statistically significant, in both OLS and PPML estimations. Similarly, the coefficients of interaction variables between asset tangibility and financial development remain negative and statistically significant, in both estimation methods.

A.2 OLS estimate

Table A2 show the result of estimating equation 7 using OLS estimator. The main result remains consistent with PPML estimation as in my baseline result in table 2.

A.3 Proof

The static problem of profit maximization, as discussed in Section 2, is written as:

$$\begin{aligned}
\Pi(a,z,e',e) = \max_{n,n^*,q,q^*} \; & pq - \omega n + e'[p^*q^* - \omega n^* - \omega F - (1-e)\omega S] \\
\text{s.t. } \; & n = \frac{q}{z} \\
& n^* = \frac{\tau q^*}{z} \\
& q = (\frac{p}{P})^{-\sigma} Q \\
& q^* = (\frac{p^*}{P^*})^{-\sigma} Q^* \\
& \lambda a \geq \alpha\omega n + e'[\omega n^* + \omega F + (1-e)\omega S]
\end{aligned}$$

With the focus on exporter ($e' = 1, e = 1$), and substituting the constraints on n, n^*, q, q^*, we could rewrite the problem as:

$$\begin{aligned}
\Pi(a,z) = \max_{q,q^*} \; & PQ^{\frac{1}{\sigma}} q^{1-\frac{1}{\sigma}} - \frac{\omega q}{z} + [P^* Q^{*\frac{1}{\sigma}} q^{*1-\frac{1}{\sigma}} - \frac{\omega \tau q^*}{z} - \omega F] \\
\text{s.t. } \; & \lambda a \geq \frac{\alpha\omega q}{z} + \frac{\omega\tau q^*}{z} + \omega F
\end{aligned}$$

Solving the optimization problem with Lagrangian:

$$\mathcal{L} = \max_{q,q^*} PQ^{\frac{1}{\sigma}} q^{1-\frac{1}{\sigma}} - \frac{\omega q}{z} + [P^*(Q^*)^{\frac{1}{\sigma}}(q^*)^{1-\frac{1}{\sigma}} - \frac{\omega\tau q^*}{z} - \omega F] + \mu[\lambda a - \frac{\alpha\omega q}{z} - \frac{\omega\tau q^*}{z} - \omega F]$$

which yields first order condition and complementary slackness:

$$\begin{aligned}
\text{FOC}(q)\text{: } & (1-\frac{1}{\sigma})PQ^{\frac{1}{\sigma}}q^{-\frac{1}{\sigma}} - \frac{\omega}{z} - \frac{\mu\omega\alpha}{z} = 0 \\
\text{FOC}(q^*)\text{: } & (1-\frac{1}{\sigma})P^*(Q^*)^{\frac{1}{\sigma}}(q^*)^{-\frac{1}{\sigma}} - \frac{\omega\tau}{z} - \frac{\mu\omega\tau}{z} = 0 \\
\text{complementary slackness: } & \mu[\lambda a - \frac{\alpha\omega q}{z} - \frac{\omega\tau q^*}{z} - \omega F] = 0
\end{aligned}$$

where μ is denotes the effect of credit constraint on profit maximization. Below, assuming the credit constraint binds and hence $\mu > 0$ becomes a state variable. From FOC(q^*), we could derive optimal quantity of q^*, denoted as $\hat{q}^*$. The corresponding export level of the firm:

$$\begin{aligned}
(\hat{q}^*)^{-\frac{1}{\sigma}} &= \frac{\sigma}{\sigma-1}(P^*)^{-1}(Q^*)^{-\frac{1}{\sigma}}\frac{\omega\tau(1+\mu)}{z} \\
\hat{p}^*\hat{q}^* &= P^*(Q^*)^{\frac{1}{\sigma}}[\frac{\sigma}{\sigma-1}(P^*)^{-1}(Q^*)^{-\frac{1}{\sigma}}\frac{\omega\tau(1+\mu)}{z}]^{1-\sigma} \\
&= (P^*)^{\sigma}Q^*[\frac{\sigma}{\sigma-1}\frac{\omega\tau(1+\mu)}{z}]^{1-\sigma}
\end{aligned}$$

Follow similar step, we could also derive the optimal domestic production:

$$\hat{p}\hat{q} = P^{\sigma}Q[\frac{\sigma}{\sigma-1}\frac{\omega(1+\alpha\mu)}{z}]^{1-\sigma}$$

The export intensity therefore could be expressed as:

$$\begin{aligned}
\text{EI} \equiv \frac{\hat{p}^*\hat{q}^*}{\hat{p}^*\hat{q}^* + \hat{p}\hat{q}} &= \frac{(P^*)^{\sigma}Q^*[\frac{\sigma}{\sigma-1}\frac{\omega\tau(1+\mu)}{z}]^{1-\sigma}}{(P^*)^{\sigma}Q^*[\frac{\sigma}{\sigma-1}\frac{\omega\tau(1+\mu)}{z}]^{1-\sigma} + P^{\sigma}Q[\frac{\sigma}{\sigma-1}\frac{\omega(1+\alpha\mu)}{z}]^{1-\sigma}} \\
&= \frac{(P^*)^{\sigma}Q^*[\tau(1+\mu)]^{1-\sigma}}{(P^*)^{\sigma}Q^*[\tau(1+\mu)]^{1-\sigma} + P^{\sigma}Q[1+\alpha\mu]^{1-\sigma}}
\end{aligned}$$

To examine the effect of credit constraint on export value and export intensity, take the partial derivative of export value and export intensity with respect to μ:

$$\frac{\partial \hat{p}^*\hat{q}^*}{\partial \mu} = (1-\sigma)(P^*)^\sigma Q^*[\frac{\sigma}{\sigma-1}\frac{\omega\tau(1+\mu)}{z}]^{-\sigma}\frac{\sigma}{\sigma-1}\frac{\omega\tau}{z}$$

$$\frac{\partial \text{EI}}{\partial \mu} = \frac{(\hat{p}^*\hat{q}^* + pq)\frac{\partial \hat{p}^*\hat{q}^*}{\partial \mu} - \hat{p}^*\hat{q}^*(\frac{\partial \hat{p}^*\hat{q}^*}{\partial \mu} + \frac{\partial \hat{p}\hat{q}}{\partial \mu})}{(\hat{p}^*\hat{q}^* + pq)^2}$$

(denominator is positive, focus on numerator)

$$\Rightarrow P^\sigma Q(P^*)^\sigma Q^*(\frac{\sigma}{\sigma-1}\frac{\omega(1+\alpha\mu)}{z})^{-\sigma}(\frac{\sigma}{\sigma-1}\frac{\omega\tau(1+\mu)}{z})^{-\sigma}\tau(1-\sigma)(1-\alpha)$$

Following conventional logic, P, Q, ω, z are assumed to be positive. As discussed in environment in section 2, $\alpha \in [0,1]$. A realistic assumption is to assume $\alpha \in (0,1)$ since firms do not always pay all of its domestic production expense in advance. Although elasticity of substitution $\sigma \in (0,\infty)$, the partial derivative is in real number if and only if $\sigma > 1$, and hence the discussion below further impose the assumption that $\sigma > 1$. [1] With these assumptions on parameters, we could then argue that:

$$\frac{\partial \hat{p}^*\hat{q}^*}{\partial \mu} < 0; \frac{\partial \text{EI}}{\partial \mu} < 0$$

Note that in extreme case where if firms have to pay all domestic production cost also in advance ($\alpha = 1$), then we would have:

$$\frac{\partial \hat{p}^*\hat{q}^*}{\partial \mu} = 0; \frac{\partial \text{EI}}{\partial \mu} = 0$$

[1] If $\sigma < 1$, $[\frac{\sigma}{\sigma-1}\frac{\omega\tau(1+\mu)}{z}]^{-\sigma}$ is a complex number.

Appendix Tables

Table A1: Replication: Log(Gross Export)

	OLS		PPML	
	(1)	(2)	(3)	(4)
	log export	log export	log export	log export
exporter FD × efd	0.211***	0.205***	0.017***	0.016***
	(0.00)	(0.00)	(0.00)	(0.00)
exporter FD × at	-5.065***	-4.905***	-0.308***	-0.298***
	(0.08)	(0.08)	(0.01)	(0.01)
importer FD	-0.183**	0.496***	-0.025***	0.020***
	(0.08)	(0.06)	(0.01)	(0.00)
importer FD × efd	0.022*	-0.046***	0.003***	-0.002***
	(0.01)	(0.00)	(0.00)	(0.00)
importer FD × at	3.616***	0.609***	0.261***	0.068***
	(0.24)	(0.09)	(0.02)	(0.01)
exporter FD		1.330***		0.077***
		(0.06)		(0.00)
FE: Ex-Time Im-Ind	Yes	No	Yes	No
FE: Ex Im Ind Time	No	Yes	No	Yes
N	1,036,870	960,728	1,036,870	960,728

Table A2: Baseline OLS estimates

	(1) log_va	(2) log_va	(3) log_va	(4) log_sh	(5) log_sh	(6) log_sh
exporter FD × efd	0.349***		0.197***	0.005***		-0.004***
	(0.00)		(0.00)	(0.00)		(0.00)
exporter FD × at		-7.510***	-6.285***		-0.374***	-0.401***
		(0.07)	(0.08)		(0.01)	(0.01)
importer FD × efd	-0.043***		0.029**	0.002**		-0.000
	(0.01)		(0.01)	(0.00)		(0.00)
importer FD × at		2.831***	3.027***		-0.119***	-0.122***
		(0.22)	(0.25)		(0.02)	(0.02)
importer FD	0.619***	-0.024	-0.081	-0.001	0.026***	0.027***
	(0.05)	(0.07)	(0.08)	(0.00)	(0.00)	(0.01)
FE: Ex-Time Im-Ind	Yes	Yes	Yes	Yes	Yes	Yes
N	1,002,907	1,002,907	1,002,907	1,036,870	1,036,870	1,036,870