Credit Airlines: Financing, Modes of Export, and Comparative Advantage*

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January 20, 2026

Abstract

We investigate how transport-mode–specific payment lags and access to finance jointly shape comparative advantage. Using a novel Colombian dataset linking banks, firms, exports, and export payments, we document three facts. First, many products are shipped by both air and sea. Second, sea shipments experience payment lags of about one quarter relative to air, raising working-capital needs for maritime exports. Third, better access to bank credit reduces the likelihood of shipping by air. We build and calibrate a trade model where firms borrow to finance production until delivery and choose between fast air or slow sea; the payment-lag channel explains about 10 percent of finance-driven changes in comparative advantage.

Keywords: transportation, access to finance, comparative advantage
JEL Codes: F12, R40, F65

*We would like to thank Tibor Besedes, Andrew Bernard, Russell Hillberry, Carsten Eckel, Manuel García-Santana, Miguel Sarmiento, Pablo Ottonello, David Pérez-Reyina, Joaquín García-Cabo, Ricardo Correa, Friederike Niepmann, and Daniel Ramos-Menchelli for their helpful comments. We are grateful for the feedback of seminar participants at the FED Board, Banco de la República de Colombia, Universidad Eafit and NYUAD. The views in this paper are solely the responsibility of the authors. They should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System or any other person associated with the Federal Reserve System, nor the views of the Colombian Central Bank or its Board of Directors. We have no sources of research support, no financial relationships, and no other potential conflicts of interest to disclose.

1 Introduction

There is a growing literature showing that transportation decisions are central to international trade patterns. Much less is known about how transport-mode–specific shipping lags affect firms' working-capital needs, how cost of finance shapes the choice of transport mode, and how this margin feeds into sectoral specialization and comparative advantage. Recent episodes in global shipping have highlighted that slower maritime shipments can lock up working capital for months, especially for those with less access to external financing.[1]

We use a novel dataset that links customs export shipment records with data on payment received for export transactions for Colombia. We show that transactions shipped by sea face systematically longer payment lags than those shipped by air, implying higher working-capital needs for maritime shipments.[2] Building on this finding, we show that the probability of shipping by air decreases with better access to banking, highlighting the role of finance in transport-mode choice. Since air intensity varies by type of good, access to banking further has implication for a country's comparative advantage through transportation-mode in addition to traditional channels such as sectoral heterogeneity in external finance requirement.

In this paper, the central mechanism is the differential in timing of payments across transport modes. Firms that ship by sea wait longer to be paid simply because their goods spend more time in transit, so each shipment ties up working capital for longer than an equivalent air shipment. This longer financing horizon can make fast air freight relatively more attractive as a way to shorten the cash-flow cycle. In this environment, better access to bank credit relaxes working-capital constraints and allows firms to tolerate slower payment cycles, shifting their shipping choices toward sea freight and ultimately affecting which sectors and firms can profitably serve distant markets.

We develop a trade model where firms need external financing for both production and shipment, where the shipment-related financing depends on the mode of transport. We use the model to quantify how cheaper external finance affects modal choice and comparative advantage. Lowering the average Colombian interest rate decreases air share and shifts the comparative advantage of the country towards sea-intensive sectors and towards sectors with

[1] For instance, the COVID-19 Pandemic (2020–2021) generated severe port congestion and container shortages that added weeks to many sea shipments. Another example is the Suez Canal Blockage (March 2021), which forced ships to wait or reroute around the Cape of Good Hope, delaying deliveries by up to several weeks. Finally, the Red Sea Crisis (2023–ongoing) has led carriers to reroute traffic away from the Red Sea, lengthening Asia–Europe sea routes by roughly 10–14 days. In all three cases, longer and more uncertain sea transit and port times extended the period between shipment and payment, tying up firms' working capital in goods stuck at sea or in congested ports.

[2] Higher payment lags don't imply delinquency, our statement is only about the lag between when the shipment leaves Colombia and when the payment is received.

high financing need in production.

Empirical facts In the first part of the paper, we use detailed Colombian administrative data from 2008 to 2019 to document three facts. First, air intensity varies by good, but many products are shipped by both air and sea: about 15% of goods never use air, around 10% always use air, and air shares range from near zero for bulky, low-value items to one for high-value or highly perishable goods.[3] This combination of mode specialization and within-good substitutability implies that firms generally can choose between air and sea, and leaves scope for financial conditions to matter for mode choice.

Second, using our data on export payments, we show that firms shipping by sea face a larger gap between shipment and payment, potentially increasing their reliance on external finance. We use firm–month data on exports and associated inflows to measure payment delays relative to the last shipment and do not find evidence that different transport modes generate more ex-ante working-capital financing through advance payments. More importantly, firms shipping by air receive payments on average about three months earlier than firms shipping by sea.

Third, we show that better access to bank credit leads firms to substitute away from fast, expensive air freight toward slower, cheaper sea freight. Using shipment-level data linked to firm-level credit, we estimate how alternative measures of banking access—interest payments to sales, interest rates, total debt, and number of loans—affect the probability that an export is shipped by air, controlling for shipment value, rich origin–destination–good–time fixed effects, and lagged firm characteristics. Across all measures, greater access to banking credit lowers the likelihood of using air.

To disentangle credit supply from credit demand, we instrument credit access with firms' exposure to banks' Tier 1 capital ratios, a standard measure of core loss-absorbing capacity that proxies banks' ability to sustain lending. Firms more exposed to better-capitalized banks experience exogenous improvements in credit conditions, and a one–standard deviation increase in interest-payments-to-sales in this IV framework reduces the probability of air shipping from 51% to 23%, which, in back-of-the-envelope terms around the sample average, implies transport cost savings of about 5.6% of annual sales, a 51.9% decline in the value of exports sent by air, and an annual reduction of roughly 43,000 tons of CO_2, or 0.17% of total air-shipment emissions in the sample.

Quantitative framework and counterfactual To quantify the impact of financial access on aggregate air usage and on comparative advantage we then develop a two-country

[3] Lugovskyy et al. (2025) find a similar pattern using U.S. import data.

international Krugman model with multiple sectors, working capital constraints and choice of transportation modes. The framework of our model captures our three empirical facts. Sector-mode specific trade costs and taste shifters drive heterogeneity in sectoral air intensity. Firms need to pay their factor of production immediately but shipments are paid only upon delivery, so they need to borrow and incur interest costs until delivery. Delivery times are mode-specific and firms choose their shipping mode optimally. In doing so, they face a trade off between higher interest cost if they ship by sea versus potentially lower iceberg shipping cost. A tractable discrete choice model delivers a key mode-switching elasticity that governs how a change in relative mode shipping costs –including time financing cost– translates into modal share. The model can be aggregated at the sectoral level such that the average sectoral export cost depends on all modes' specific iceberg costs, delivery lags and interest rate.

Credit access is modeled as an exogenous wedge in interest rates.[4] A decrease in interest rate increases the share of air within a sector and decreases overall export costs. In particular, export costs of sectors that are relatively sea-intensive – for example bulky items with a lower relative cost of sea – decrease more. As a consequence, sectoral composition of exports tends to shifts towards sea-intensive sectors.

Sectors also differ in their overall time to build and hence have heterogeneous exposure to financing cost regardless of shipping decisions. Hence, change in sectoral composition is driven by two channels. The first channel is well known: reduction in overall financial cost shifts comparative advantage towards finance-dependent sectors (Manova, 2008).[5] The second channel is novel: reduction in the financial cost of longer sea shipment lags shifts comparative advantage towards sea-intensive sectors.

To discipline the model, we use the customs data to compute trade shares and mode shares. We estimate the elasticity of substitution across mode in a theory-consistent regression. We regress sectoral mode share on sectoral interest rates, using variation in interest rate across sectors and time. The resulting coefficient has the structural interpretation of the mode elasticity combined with the difference in payment lag between air and sea. Finally, we use firm balance sheet data to match sectoral debt-to-sales ratio as a way to discipline the sectoral heterogeneity in external finance exposure in production.

Our main counterfactual lowers the average Colombian interest rate to the level of the

[4]We model access to finance following Ramos-Menchelli and Van Doornik (2023) who consider that credit monitoring costs are a deadweight loss. We abstract from modeling access to finance channels such as trade finance, loan guarantees, letter of credit, and insurance. For more details on how these issues impact exporters see Garcia-Marin et al. (2023), Niepmann and Schmidt-Eisenlohr (2017a), Niepmann and Schmidt-Eisenlohr (2017b), and Schmidt-Eisenlohr (2013)

[5]We abstract from the well-studied distinction between extensive and intensive margin (Manova, 2013).

US interest rate. This results in a decrease in air share by 1.2pp out of a baseline of 26%. The majority of this shift happens within sector, with sea shipment becoming relatively cheaper than air due to reduced financing cost. A smaller part is due to reallocation towards sea-intensive sectors. Our calibration implies that while the first channel accounts for the majority of change in specialization, our novel channel still accounts for about 10% of the variation in sectoral revealed comparative advantage in our counterfactual.

Our model can also be used to compute the change in CO2 emission due to the change in air shipment. We find that emissions drop slightly when interest rate decrease due to the switch towards the less polluting maritime mode, even though aggregate exports increase.

Related literature This paper contributes to three strands of literature. First, it adds to work on the link between access to finance and international trade by using novel data on export payments that reveal the payment lags faced by sea exporters and by providing causal evidence that better access to bank finance reduces the probability of shipping by air. Within this literature, this paper is closely related to studies of how credit shocks and financial frictions shape the performance of exporting firms (Besedes et al., 2014; Federico et al., 2023; Feenstra et al., 2014; Minetti and Zhu, 2011; Paravisini et al., 2023, 2015; Alfaro et al., 2025). We also contribute to the trade credit literature, which studies how firms use supplier credit to finance transactions when financial frictions are present (Raddatz, 2010; Cai et al., 2014; Fabbri and Klapper, 2016; Chod et al., 2019; Fisman and Love, 2003; Wu et al., 2014); here, we highlight the additional financing needs borne by the firm that extends trade credit to cover longer payment lags dependind on the mode of transportation.

Second, our work relates to the literature on transportation and international trade (Ganapati et al., 2024; Ducruet et al., 2024; Baldomero-Quintana, 2025; Bonadio, 2024) and on air shipment specifically (Hummels and Schaur, 2013; Harrigan, 2010). Regarding the substitutability and complementarity across mode, Tolva (2024), Lugovskyy et al. (2025) and Fuchs and Wong (2024) are related papers. Here, we introduce the role of external finance in modal choice and study how the interaction between transportation modes and external finance cost shape comparative advantage.

Last, our paper contributes to the macro-development literature on financial frictions and comparative advantage (Bahar and Rapoport, 2018; Manova, 2013; Levchenko, 2007; Morales, 2023). We introduce an additional channel through which financial conditions shape sectoral structure. Building on work that links financial development to countries' specialization patterns, we show that access to finance also operates through firms' transport-mode choices and the associated payment delays. In this sense, the paper complements existing evidence that finance matters for export selection and performance by highlighting trans-

portation and delivery time as another mechanism connecting financial development and comparative advantage.[6]

We proceed as follows. Section 2 describes the data. Section 3 presents the empirical evidence. Section 4 develops the theoretical model. Section 5 reports the main counterfactual results. Section 6 concludes.

2 Data and Summary Statistics

We use four administrative data sources on Colombian firms from 2008 to 2019, focusing on exporting firms that we link to their export payments, financial statements, and bank credit. A key feature of our setting is novel transaction-level data on export payments, which allow us to observe the timing and structure of foreign-currency inflows associated with exports.

- **Customs**. Our dataset contains all international trade transactions between 2008 and 2019 for Colombia. The source is the Colombian tax and customs office, (*Departamento de Admistrativo de Impuestos y Aduanas Nacionales* or DIAN). For each transaction, we observe the good, weight, units, date, mode of transportation, firms, the city of origin, the city of destination, and the value of the shipment.

- **Export payments**. We use exports' payments data (*Formato 2*, *Banco de la República de Colombia*). Banco de la República records these data when registering foreign-currency inflows into Colombia associated with export transactions. For each observation, we see every payment received by an exporting firm, explicitly labeled as a payment for exports and classified as an advance payment, a payment made within one year of the export date, or a payment made more than one year after the export.

- **Bank credit**. We use data from the Colombian credit registry (*Formato 341*). In this dataset, we observe exporting and non-exporting firms' loan characteristics such as interest rate, maturity, total balance, interest payments, and the loan openings' dates.

- **Financial statements**. We obtain firm's financial reports from the *Superintendencia de Sociedades*, a Colombian government agency that oversees and regulates large private Colombian corporations.[7] The private firms in this dataset are among the largest

[6] Our analysis focuses on how financial development shapes comparative advantage through transport-mode choice and payment delays, abstracting from potential feedback effects running from specialization patterns to financial development. (Do and Levchenko, 2007).

[7] See, appendix A for further details on exports data, and Aristizábal-Ramırez and Posso (2021) for further details on firm's balance sheet and credit registry

in Colombia. [8] We use information on balance sheet characteristics such as sales, leverage, cash-to-assets, inventory-to-assets and the sector of every firm.

- **FDI inflows.** We obtain data on FDI inflows from *Formato 4* (*Banco de la República de Colombia*), which records the sender and receiver firms, transaction values, and types of investment.

We use these sources to construct two complementary datasets. First, we build a firm–month panel that combines exports and associated payment inflows to study the timing of export payments relative to shipment dates, following Alfaro et al. (2024). One drawback of our data is that while we observe total incoming international payment for each month at the firm-level, we cannot match it to a specific transaction. Hence, we collapse our data to the monthly level and focus on isolated export shipments, where we can safely attribute a payment to a transaction. We restrict the sample to payments made from the month of the first shipment onward, and to payments following any shipment that occurs at least one year after the previous shipment. Further, we drop shipments that are followed by another shipment in the same year. We argue that those restrictions guarantee that the observed payment relates to the last observed shipment. Panels A and B of table 1 summarize this dataset: Panel A shows that most payments are short-term (within one year of the shipment), with long-term payments (over one year) accounting for only a small share. Panel B plots variables relative to months since the last export and reveals that firms, on average, receive advance payments, but the mean payment arrives about 11 months after the last shipment, with substantial dispersion as the median payment occurs within one month, and shipment values—mostly transported by air—range from roughly one thousand to 414 thousand USD.

Second, we merge export transactions with annual firm-level financial statements and bank credit information. The resulting dataset covers 4,314 exporting firms with both balance sheet and credit registry data and includes 4,771,563 export transactions, which we use to study how access to bank credit shapes the probability of shipping by air. Panels C and D of Table 1 summarize this dataset: the average shipment is valued at about 30,000 USD, 52% of transactions use air freight, average annual sales per firm are roughly 30 million USD (around three times the average for all Colombian firms), the mean leverage ratio (total liabilities over total assets) is 0.37, and firms face an average interest rate of 7.9 percent, approximately 0.6 percentage points below the economy-wide corporate loan rate over the same period.[9]

[8] The average sales of the Colombian firms in this dataset amount to 10 million USD. This reflects that

Table 1: Summary Statistics

	Mean	Std. Dev	Pctile. 5	Median	Pctile. 95	N
A.Payments, monthly						
Total payments$^{(k)}$	31	480	0	0	53	135501
Short term payments$^{(k)}$	19	300	0	0	35	135501
Advanced payments$^{(k)}$	12	296	0	0	12	135501
Long term payments$^{(k)}$	0.04	2	0	0	0	135501
B. Exports and Payments, monthly						
Prob. of receiving advanced payments	0.66	0.47	0	1	1	1162894
Months since last shipment	11	14	0	4	41	1162894
Last export by air (dummy)	0.60	0.48	0	1	1	1162894
Export value of last transaction$^{(k)}$	153	1166	1	14	414	1162894
C. Export transactions						
Unit value (USD per unit)	253	13936	0.13	4.3	131	4559233
Air (dummy)	0.52	0.50	0	1	1	4559233
Export value$^{(k)}$	28	264	0.04	2.2	79	4559233
Modal share of export value	0.5	0.48	0	0.49	1	297634
D.Financial Statements						
Sales$^{(m)}$	31	121	0.66	5.9	126	19662
Leverage (ratio)	0.37	0.24	0.05	0.35	0.76	19658
Inventory to assets (ratio)	0.21	0.15	0.01	0.19	0.49	19658
Cash to assets (ratio)	0.06	0.08	0	0.03	0.22	19658
Sales growth (%)	6.9	364	-35	1.4	43	19662
FDI receipt (dummy)	0.05	0.22	0	0	1	19736
E. Credit Registry						
Int. payments to sales (%)	0.79	2.7	0	0.2	2.8	19736
Total debt$^{(m)}$	13	50	0.01	1.5	59	19736
Number of active loans	8.6	7.0	1	7	23	19736
Int. rate	7.9	6.3	1.1	6.3	22	17799
Instrument	0.76	0.82	0	0.57	2.1	19736
Tier 1 capital ratio	17.06	12.39	10.60	14.09	32.82	274

Note: This table reports summary statistics at the firm, export transaction, and monthly export-relationship levels. Superscript $^{(k)}$ denotes variables measured in 2018 USD thousands; superscript $^{(m)}$ denotes variables measured in 2018 USD millions. Pctile. 5, Median, and Pctile. 95 denote the 5th percentile, the median, and the 95th percentile of each variable, respectively. The instrument corresponds to the weighted average of a firm's exposure to banks with stronger Tier 1 capital ratios. Source: *SuperSociedades, DIAN, Formato 341, Banco de la República* and author's elaboration.

3 Empirical facts

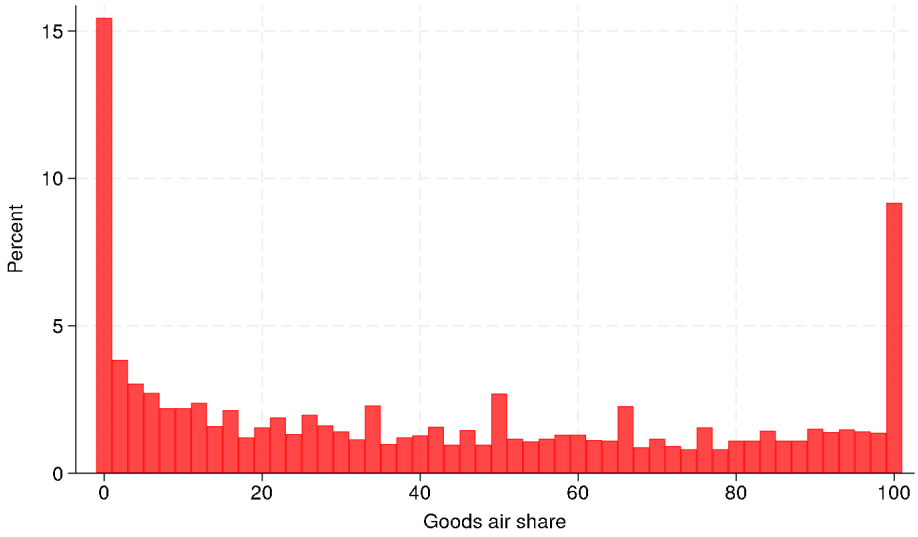
In this section, we show three empirical facts regarding access to finance and exporters' choice of mode. First, we show that most goods are shipped by both sea and air and the intensity of air usage is different across different goods. Second, we provide evidence that when firms send goods abroad via air, they receive a larger fraction of the payment upfront compared to shipping via sea. Finally, we document that firms with restricted access to finance are more likely to ship via air, since they are willing to pay higher transportation costs to increase their cash flows, allowing them to cover production costs.

the firms we consider are large, given the size of the Colombian economy.

[9]According to the Superintendencia Financiera, average effective annual interest rates for corporate loans over our sample period (2008–2019) were approximately 15.54% for ordinary commercial loans, 10.35% for preferential commercial loans, and 9.69% for treasury (short-term working-capital) loans.

Fact 1: Air intensity differs across goods with some within-good substitutability

Figure 1: Goods transport mode mix: 79% use both air and sea, 21% use only one



Note: The histogram displays the distribution of air intensity across goods exported in Colombia using HS6-digit classification. Air intensity is computed as the share of transactions within good that use air. Data Source: DIAN and author's elaboration.

We document that air intensity varies by good, but a significant proportion of goods are shipped by both sea and air.[10] Figure 1 displays a histogram of the share of air shipment in HS6 codes, using all Colombian exports from 2008 to 2019 to compute the average use of air in all transactions. The horizontal axis shows the share of goods, and the vertical axis represents the frequency of air usage.

Around 15% of good never use air shipments, and around 10% always use air. For around three-quarters of goods, shipments happen by both air and sea in Colombian exports. This mirrors findings in Tolva (2024) and Lugovskyy et al. (2025). Appendix B.1 replicates this analysis while controlling for unit value and city of destination, and further explores the share of air shipments across different dimensions—including transactions, goods, value, CO 2 emissions, and weight.

An important implication of Figure 1 is that the air usage intensity differs across different goods, ranging from 0 for bulky low-value items (e.g. wood in the rough) to 1 for high-value items or fast-depreciating that can't survive the lengthy delay of sea shipping (e.g. cut

[10] We exclude from our sample all road exports for two reasons. First, Venezuela is a small trading partner in the sample period after years of negative growth. Second, the roads leading to the customs land ports on the Colombia-Ecuador border are infrequently used due to safety reasons.

flowers, blood prepared for therapeutic, prophylactic or diagnostic uses). This finding is well documented (see eg Hummels and Schaur, 2013), and has implications for comparative advantage. If a country has a large cost of shipping by sea, it will specialize in air-intensive goods. Whether the country is completely precluded from exporting sea-intensive goods depends on the substitutability of modes within good. Figure 1 shows that most goods can be shipped by either mode, so that some substitutability exists and a country with a high cost of sea shipping might still export sea-intensive goods. Here, we focus on a novel aspect of sea shipping costs: the importance of access to finance as a way to finance the delay in payment, which we document in the next section.

Fact 2: Air shipping leads to faster payments compared to sea shipping

We provide evidence that firms that ship by sea experience a larger gap between shipment and payment, which can increase their reliance on external financing. Using our exports and payments data, we document two key features of payment timing across transport modes that imply higher working-capital needs for maritime trade.

First, we do not find evidence that firms using different transport modes obtain systematically distinct ex-ante working-capital financing from their buyers through advance payments, even after controlling for export size and a rich set of fixed effects. We estimate the difference in the probability of receiving advance payments between air and sea shipments, controlling for export size and a rich set of fixed effects, using the following regression:

$$\texttt{Adv}_{it} = \alpha_t + \beta_1 \texttt{Air}_{it} + \beta_2 \ln \texttt{value}_{it} + \delta_{\text{gap}(i)} + \gamma_{g(i)} + \eta_{d(i)} + \varepsilon_{it}, \tag{1}$$

where i is a shipment in month t. $\texttt{Adv}_{it}$ is a dummy for receiving payments recorded as advanced before shipment i in month t. $\texttt{Air}_i$ is a dummy for whether the export was made by air.[11] In some specifications, we add fixed effects for the gap between the matched export transaction and the previous or next export transaction, $\delta_{\text{gap}(i)}$. We also control for a good (HS-6) fixed effect ($\gamma_{g(i)}$), destination fixed effect ($\eta_{d(i)}$) and month fixed effect (α_t). We weight each observation by value. Table 2 shows that the probability of receiving advance payments does not differ statistically between air and sea shipments.[12]

Second, conditioning on the good and destination, we observe that firms shipping by air receive payments around 3 months earlier than those shipping by sea, by estimating the

[11] In the rare cases where a firm shipped by both air and sea in the same month, we compute the share of air weighted by value.

[12] Recall that advanced payments are directly identified in the payments dataset, so measuring them does not require matching individual payments to specific shipments

Table 2: Air and sea shipments are equally likely to receive advanced payments

	Prob. of receiving advanced payments		
	(1)	(2)	(3)
$\texttt{Air}_i$	-0.019	-0.005	0.050
	(0.027)	(0.030)	(0.035)
$\ln \texttt{value}_i$	0.007	0.018	-0.020
	(0.011)	(0.013)	(0.015)
Observations	8,880	8,875	8,513
t FE	✓	✓	✓
Time to next shipment FE		✓	✓
HS6 and destination country FE			✓

Note: This table displays the results from estimating equation (1). All regressions are weighted by export value. Standard errors are clustered at the month level.

payment delay differential between air and sea shipments.[13]

For each incoming payment, we compute the time delay between the month of payment and the last month of export recorded for the firm. We then compare this delay for transactions by air or sea, controlling for the size of the transaction and a variety of fixed effects. Similarly to Equation 1, we estimate the following regression:

$$\texttt{delay}_{it} = \alpha_t + \beta_1 \texttt{Air}_{it} + \beta_2 \ln \texttt{value}_{it} + \delta_{\text{gap}(i)} + \gamma_{g(i)} + \eta_{d(i)} + \varepsilon_{it}, \tag{2}$$

where i is an incoming international payment, $\texttt{delay}_i$ is the difference, in number of months, between a payment and the date since the last shipment. Since we weight each observation by value, the coefficient can be interpreted as the difference in average number of months taken to receive a dollar for an air shipment relative to a sea shipment.

Table 3 displays the results. Throughout all specifications, the coefficient on the air variable is negative and significant, implying that shipments sent by air are paid earlier than those shipped by sea, even controlling for shipment size, good, and destination.

Limitations. The exercise in this section has some limitations. First, the sample is restricted to the first export. Appendix Table 9 expands the sample to any shipment happening at least a year after the previous shipment, with similar results. Appendix B.2 also presents results of an event study around the first shipment, which reveals that most air shipments are paid within a month while sea shipments take up to six months. Second, we cannot see domestic payments that the firm could receive from selling its claim on the importer to a third party. Nevertheless, those factoring arrangements typically come at a discount, so that

[13]Since we show there is no differential difference in advance payment between air and sea, there is no loss from focusing on payments happening after the shipment.

Table 3: Air shipments are paid around 3 months earlier

	Time since shipment ($\texttt{delay}_i$)		
$\texttt{Air}_i$	-3.550***	-2.991***	-1.949**
	(0.734)	(0.703)	(0.829)
$\ln \texttt{value}_i$	-1.620***	-1.380***	-0.712**
	(0.184)	(0.169)	(0.293)
Observations	8880	8875	8513
t FE	✓	✓	✓
Time to next shipment FE		✓	✓
HS6 and destination country FE			✓

Note: This table displays the results from estimating equation (2). All regressions are weighed by export value. Standard errors are clustered at the month level.

they also impose a "financing" cost to the firm.

Fact 3: Firms with lower access to finance use more air shipments

Now, we show that firms with more access to finance reduce the use of air mode. We start by estimating the following equation to capture the effect of higher access to banking credit on the probability of air shipments:

$$\texttt{Air}_{odgjmts} = \beta_0 + \beta_1 \texttt{creditAccess}_{jt} + \beta_3 \log(\texttt{unitValue})_{odgjmt} + \alpha_{ts} + \alpha_{odgm} + X'_{jt}\beta + \epsilon_{odgjmts}, \tag{3}$$

where $\texttt{Air}_{odgjmts}$ takes the value of one if the export transaction uses air, and zero otherwise, for a shipment of firm j, in month m, year-sector ts of good g from origin o to destination d. The coefficient of interest β_1 measures how firm's access to credit, $\texttt{creditAccess}_{jt}$, affect the probability of shipping by air for those firms that have at least one loan.

We use four complementary measures of access to finance: Interest payments to sales, interest rate, total debt, and number of loans. Our prefered measure of access to finance is interest payments to sales, calculated as annual interest paid divided by initial sales. It measures the effective use of external financing, meaning that higher interest payments to sales indicates higher debt-dependence (Feenstra et al., 2014). We keep sales constant for every firm and use their first year sales t_1 to avoid capturing the dynamics of firms' sales. The average interest rate represents the cost of capital: lower rates imply easier access, while higher rates reflect stricter and more expensive lending conditions. Total debt assesses the size of a firm's bank borrowing, revealing its reliance on external finance unconditionally of the firm size. Lastly, we measure access in terms of the number of active loans. We construct a dummy for having a number of loans above the median, quantifying the breadth of a firm's

engagement with banks (Behr et al., 2011; Diamond, 1991); firms with more loans typically enjoy broader, diversified access to credit. Together, these measures allow us to assess how both the presence and scope of bank financing shape firms' shipping choices. We standardize our first three measures. Hence, our results are interpreted as the semi-elasticities.[14]

We include a broad set of controls. First, we control for the unit value of each shipment, $\log(\texttt{unitValue})_{odgjt}$, as more valuable shipments are more likely to be shipped by air. Second, we include origin-destination-good-month fixed effects α_{odgt} thus capturing specific modes for goods that are always traded between two cities i.e., flowers sent from Bogotá to Mexico City via air and seasonality effects. We use HS6 code for goods. We also include time-sector fixed effects, α_{ts}, to capture aggregate dynamics.[15] Hence, our identification comes from comparing firms in the same year and sector, shipping the same good, with the same unit value, from the same origin to the same destination and month, using two modes of transportation. We acknowledge that there could be additional firm observable characteristics that could potentially affect this decision that are related to firm size, growth, additional sources of financing, and inventories. Therefore we include a large set of lagged controls that comprise sales, de-meaned leverage, inventory to assets, cash to assets, sales growth and FDI receipt in the extensive margin (Foley and Manova, 2015; Evans and Harrigan, 2005; Deardorff, 2003; Iannotta and Kwan, 2022; Ottonello and Winberry, 2020; Hennessy et al., 2007).

Panel A of Table 11 shows that greater access to bank credit lowers the probability of shipping by air. A one–standard deviation increase in interest payments over sales—our main measure of banking access—reduces the air-share by about 3 percentage points (from 51% to 48%), or 5.7% of total air shipments. Alternative measures of credit access point in the same direction: higher interest rates are associated with a small, marginally significant increase in air use, while higher total debt and a larger number of loans both significantly reduce the share of air shipments. These results are consistent with better-financed firms substituting away from fast, expensive air freight toward slower, cheaper sea freight, tolerating longer payment delays in exchange for higher profitability per shipment.[16]

[14] Notice that all our measures capture only the intensive margin of access to banking loans. We show in the appendix that the extensive margin is not a critical dimension of how access to credit affects the mode of transportation (see Table 11 in the Appendix), where we regress the probability of shipping by air on a dummy variable equal to 1 if firm j has at least one active loan in year t, and interact each of the intensive margin measures with this dummy.

[15] In Appendix Tables 13 and 14 we show that results are robust to including different sets of fixed effects. As part of those specifications, we also include firm fixed effects, which capture the fact that some firms always prefer to use a specific mode due to geographical circumstances, contracts, or specific supply chain need.

[16] Appendix Table 15 shows similar signs for short- and long-term components of our intensive-margin credit measures.

Table 4: Higher Access to Banking Credit Reduces the Probability of Shipping by Air

	(1)	(2)	(3)	(4)
Panel A: Baseline Estimates				
Int. payments to sales	-0.026***			
	(0.009)			
Int. Rate		0.007*		
		(0.004)		
Total debt			-0.011***	
			(0.003)	
More loans				-0.011**
				(0.005)
Unit value	0.021***	0.020***	0.021***	0.021***
	(0.002)	(0.002)	(0.002)	(0.002)
Origin-Dest-Good-Month FE	✓	✓	✓	✓
Year_Sector FE	✓	✓	✓	✓
Firm level Controls	✓	✓	✓	✓
N	4,559,233	4,310,538	4,566,662	4,568,834
Panel B: IV Estimates				
Int. payments to sales	-0.288***			
	(0.077)			
Int. Rate		0.075***		
		(0.022)		
Total debt			-0.037***	
			(0.009)	
More loans				-0.257***
				(0.093)
Unit value	0.020***	0.020***	0.021***	0.019***
	(0.002)	(0.002)	(0.002)	(0.002)
Origin-Dest-Good-Month FE	✓	✓	✓	✓
Year_Sector FE	✓	✓	✓	✓
Firm level Controls	✓	✓	✓	✓
N	4,559,233	4,310,538	4,566,662	4,568,834

Note: This table displays the estimated coefficients for the impact of banking credit access on the likelihood of shipping by air. Panel A shows baseline estimates for equation 3 using alternative measures for β_1: (1) Interest payments to sales (standardized); (2) Interest rate (standardized); (3) Total debt (standardized); and (4) Dummy for having a number of loans above the median. Panel B reports IV estimates, where the instrument is defined by the firm's exposure to healthier banks (see equation 4). The variable "Unit value" measures the shipment value divided by the number of units in logs. In both panels, total debt is total outstanding bank loans, interest payments to sales is annual interest payments to banks over first sales, and "more loans" is a dummy for firms above the sample median number of bank loans. Firm-level controls include sales, inventory-to-assets, leverage, cash to assets, sales growth and FDI receipt in the extensive, which are lagged by one year. Robust standard errors are clustered at the firm-year level. *** : $p < 0.001$, ** : $p < 0.05$, * : $p < 0.1$.

Reverse causality and IV. One potential concern with our results is that they may be driven by changes in firms' credit demand rather than by firms' access to credit. In the second part of the analysis, we address this issue by isolating credit supply using an instrumental variable approach. Specifically, we exploit variation in banks' ability to absorb losses and their overall financial strength. To implement this approach, we rely on the Tier 1 capital ratio, a regulatory measure defined as a bank's core equity capital divided by its total

risk-weighted assets (RWA) (Correia et al., 2024; Jiménez et al., 2017; Gropp et al., 2019; Ormazabal et al., 2025). The Tier 1 capital ratio reflects a bank's aggregate capitalization and risk exposure rather than the borrowing, investment, or credit demand decisions of any individual firm. It is instead shaped by the bank's historical profits, capital raising choices, and risk management policies. A higher Tier 1 ratio is associated with a stronger financial position, hence a stronger ability to lend. We therefore define our instrument as the weighted average of a firm's exposure to banks with stronger Tier 1 capital ratios, as follows

$$Z_{jt} = \sum_{b} \omega_{jbt-1} \times \text{Tier1}_{b,t} \tag{4}$$

where ω_{jbt-1} is the share of the average value of the loans that firm j had with bank b in period $t-1$, and $\text{Tier1}_{b,t}$ is the tier I capital ratio of bank b on December of year t. An increase in Z_{jt} can be interpreted as an exogenous change in credit access for firm j. Using our instrument, we estimate Equation 3 using 2SLS. We present and discuss the first stage, reduced form, and instrument balancing results in the appendix, on Tables 16, 17 and 18 respectively. These tables validate the relevance, strength, and exogeneity of the instrument.

Panel B of Table 11 reports the second-stage results, showing that increased access to credit is associated with a lower probability of shipping by air, with all effects statistically significant at the 95 percent level. A one-standard-deviation increase in interest payments to sales, exclusively driven by additional Tier 1 capital exposure, reduces the probability of shipping by air by 28 percentage points and lowers the share of air shipments from 51% to 23%, implying transportation cost savings of about 5.6% of annual sales and 51.9% of annual exports. An average transaction in our data weighs 1.2 tons, travels 4,000 km, and emits roughly 2.6 tons of CO_2; under the same shock, the resulting reduction in air shipments corresponds to an annual decrease of approximately 43,000 tons of CO_2, or 0.17% of total air-shipment emissions in our sample. The IV coefficient is about ten times larger than the OLS estimate, indicating that the instrument recovers a much stronger causal effect for the firms whose credit access responds most to banks' improved loss-absorbing capacity. Following Hull (2025), we characterize these compliers and show that larger firms disproportionately benefit from credit supply expansions driven by increases in the Tier I capital ratio (Perez-Reyna et al., 2025) (see Table 18 in the Appendix).

The effects for interest rates and total debt are more modest. A one–percentage point increase in the interest rate raises the probability of shipping by air by about 7.5 percentage points, while a one–percentage point increase in the debt ratio lowers it by roughly 3.7 percentage points—non-negligible, but far below the 28-percentage-point effects estimated for interest-payments-to-sales and the number of loans. Because interest payments over sales

scale debt service by firm size, they generate much larger effects on transport choice than the more unconditional debt ratio. This suggests that the cost of servicing debt, rather than leverage alone, is what primarily shifts firms away from air toward sea shipping.

4 Model

In this section, we develop a theoretical framework to measure how better financial access affects a country's comparative advantage through firms' transportation choices, and calibrate it to the Colombian economy. Building on a two-country Krugman model with multiple sectors, working capital constraints, and endogenous mode choice, we distinguish two channels through which finance matters: financing time to build, highlighted in previous work, and financing payment lags. Through the lens of the model, the payment-lag channel accounts for about 10 percent of the total impact of improved financial access on comparative advantage.

The economy consists of two regions, Colombia and the rest of the world (ROW), denoted by subscripts o or d. There are J sectors denoted by subscript j. In each region and sector, there is a continuum of firms that produce differentiated varieties. Each firm is denoted by subscript i. There is a different demand for goods shipped by air or sea (Hummels and Schaur, 2013). The population in any region o is given by L_o, and workers provide labor supply inelastically.

4.1 Demand

In each region d, there is a representative consumer with Cobb-Douglas preferences:

$$U_d = \prod_j (C_{dj})^{\alpha_{dj}} \tag{5}$$

where α_{dj} are the shares of each sector in total spending and

$$C_{dj} = \left(\int_{i \in \Omega_{dj}} a_{m(i)} \left(q_{di}\right)^{\frac{\sigma}{1-\sigma}} \right)^{\frac{1-\sigma}{\sigma}} \tag{6}$$

where Ω_{dj} is the set of available goods within sector j in region d. The parameters $a_{m(i)}$ are taste shifters that depend on the mode of transportation of each good. In general, $a_{AIR} > a_{SEA}$ due to shorter delivery lags (Hummels and Schaur, 2013).

The expenditure in region d for the good of firm i shipped by mode m for a given price

p_i is given by:

$$X_{i,odjm} = a_{mj} \left(\frac{p_{i,odjm}}{P_{dj}} \right)^{1-\sigma} \alpha_{dj} X_d, \tag{7}$$

where X_d is the aggregate expenditure and P_{dj} is the ideal price index of sector j in region d given by $P_{dj}^{1-\sigma} = \int_{i \in \Omega_{dj}} a_{m(i)} \left(p_{id}\right)^{1-\sigma}$.

4.2 Supply

A firm i in region o, sector j, produces output using labor and a constant returns to scale production technology defined by $y_i = A_{oj} l_i$. The firm can hire labor at a wage rate w_o, and must pay it in advance i.e., the firm finances its (variable) wage bill before receiving the payment for its good. We assume that firms in region o, sector j, can borrow at a gross interest rate R_{oj}. In each sector, production takes $\bar{\tau}_j$ units of time. Therefore, absent of additional shipping times, the firm would have to pay $w_o \left(R_{oj}\right)^{\bar{\tau}_j}$ for a unit of labor.[17]

Firms use two modes to ship goods between regions, air and sea. The use of each mode leads to different trade costs. A firm in sector j and region o faces an average iceberg trade cost $d_{odjm} > 1$ to deliver goods to region d that depends on the shipping mode m. Thus, it needs to produce d_{odjm} units for one unit to reach the destination. A shipment from o to d by mode m takes τ_{odjm} units of time. Furthermore, the firm faces an idiosyncratic multiplicative shock $1/\varepsilon_{ijm}$ to ship by mode m. For a given transportation mode m, the firms' profits are given by:

$$\pi_{i,jm} = p_{i,jm} \frac{A_{oj} l_i}{d_{jm}} \varepsilon_{ijm} - w l_i \left(R_{oj}\right)^{\bar{\tau}_j + \tau_{odjm}} \tag{8}$$

subject to the demand function in equation (7).

Firms implement a traditional constant mark-up pricing:

$$p_{i,jm} = \frac{\sigma}{\sigma - 1} \frac{w_o \left(R_{oj}\right)^{\bar{\tau}_j + \tau_{odjm}}}{A_{oj}} \frac{d_{odjm}}{\varepsilon_{ijm}}$$

and the mode-specific profits are given by

$$\pi_{i,jm} = \frac{1}{\sigma} \left(\frac{\sigma}{\sigma - 1} \frac{w_o \left(R_{oj}\right)^{\bar{\tau}_j + \tau_{odjm}}}{A_{oj}} d_{odjm} \right)^{1-\sigma} \left(\varepsilon_{ijm}\right)^{\sigma - 1} a_{jm} \frac{\alpha_{dj} X_d}{P_{dj}^{1-\sigma}}.$$

The firm chooses the mode of transportation that maximizes its profits. Under the assumption that ε_{ijm} follows a Fréchet distribution with shape parameter μ, the probability that

[17] We introduce interest rate payments in this static model in a reduced form way, but our model can be shown to correspond to the steady state of a dynamic model.

$\pi_{i,jm} \geq \pi_{i,jm'}$ $\forall m'$ is given by:

$$s_{odjm} = \frac{\left((R_{oj})^{\tau_{odjm}} d_{odjm} (a_{jm})^{\frac{1}{1-\sigma}} \right)^{-\mu}}{\sum_{m'} \left((R_{oj})^{\tau_{odjm'}} d_{odjm'} (a_{jm'})^{\frac{1}{1-\sigma}} \right)^{-\mu}}. \tag{9}$$

Equation (9) implies that the probability that a firm uses a given mode depends negatively on the iceberg cost (d_{odjm}) and positively on the demand shifter for the mode (a_{jm}). Since the firm needs to its costs in advance and incurs and interest rate while waiting for the shipment to reach, it also favors a faster mode of transportation (with low τ_{odjm}) all else equal. Note that the time-to-build $\bar{\tau}_j$ itself doesn't affect the mode choice. This is because the trade cost is multiplicative, so that the cost of production is irrelevant to the mode choice. The model would still allow for any correlation between $\bar{\tau}_j$ and s_{odjm} as we keep d_{odjm} and a_{jm} as free parameters, but the impact of a change in R_{oj} on s_{odjm}, however, wouldn't be mediated by $\bar{\tau}_j$. If anything, ignoring this additional channel underestimates the importance of external finance on mode switching in our model.

The parameter μ represents the elasticity of substitution between air and sea mode for all sectors. There are two extreme cases that provide intuition behind this parameter. In the first case, $\mu \to \infty$ represents the case in which air and sea mode are perfect substitutes. Thus, firms use both modes to ship a good, firms never use a single mode to ship the same good, and firms split evenly the use of each mode for every good. In the second case, $\mu \to 0$, modes are not substitutable, thus, firms exclusively use a single mode for each good. That is, goods are either sea-shipping-only or air-shipping-only. For intermediate cases, firms can switch across mode, but there remain different overall air or sea intensities by sector depending on the values of exogenous parameters such as d_{odjm} and a_{jm}.

We define the *average* export cost d_{odj} by a weighted average of the mode-specific export costs, that is:

$$d_{odj} = \left(\sum_{m} \left[(R_{oj})^{\tau_{odjm}} d_{od,jm} (a_{jm})^{\frac{1}{1-\sigma}} \right]^{-\mu} \right)^{-\frac{1}{\mu}}. \tag{10}$$

Under the Fréchet assumption, total sales to destination d from origin o in sector j are given by:

$$X_{odj} = \gamma N_{oj} \left(\frac{\sigma}{\sigma - 1} \frac{w_o R_{oj}^{\bar{\tau}_j}}{A_{oj}} d_{odj} \right)^{1-\sigma} \frac{\alpha_{dj} X_d}{P_{dj}^{1-\sigma}} \tag{11}$$

where γ includes constants and the gamma function, while N_{oj} represents the mass of firms

in region o, sector j.

Interest rate. There is a continuum of financiers in region o. They incur a cost R_{oj} of credit monitoring, and are thus willing to lend any amount at interest rate R_{oj}. We assume that:

$$R_{oj} = (R^* + \bar{R}_o) \times \rho_j \tag{12}$$

where (R^*, $\bar{R}_o$ and ρ_j are determined outside the model. $\bar{R}_o$ is a country-level wedge that depends on the country's level of financial development or the nation's financial misallocation. ρ_j is a sector-specific wedge, that can be rationalized by the presence of sector-specific monitoring costs. The financiers consume according to the same utility as the representative consumer in o.

Firms' entry. Firms in region o and sector j can enter the market by paying a fixed entry cost f_{oj} measured in units of labor. They pay the fixed cost before knowing their idiosyncratic ε_{ijm} shocks and interest rate. Firms keep entering until their expected profits are null.

Given the sales above, the zero-profit condition implies that variable profits are equal to the entry cost:

$$w_o f_{oj} N_{oj} = \frac{1}{\sigma} \sum_d X_{odj},$$

where we assume that the fixed cost can be paid at the end of the period so it doesn't require financing.[18]

4.3 Equilibrium

Under balanced trade, total expenditure by consumers in region d is equal to total wage income plus the interest rate payments: $X_d = w_d L_d + \sum_j I_{oj}$.

We formulate the equilibrium as a set of wages $\{w_d\}$, trade flows $\{X_{odj}\}$, the number of firms per region $\{N_{oj}\}$, and prices $\{P_{dj}\}$ subject to:

- Gravity equation

$$X_{odj} = \gamma N_{oj} \left(\frac{\sigma}{\sigma - 1} \frac{w_o \left(R_{oj}\right)^{\bar{\tau}_j}}{A_{oj}} d_{odj} \right)^{1-\sigma} \frac{\alpha_{dj} X_d}{P_{dj}^{1-\sigma}}$$

[18] This model is equivalent to the steady state of a dynamic model, where the firm can use receipt of past sales to pay a per-period entry cost.

- Sectoral price index for every location

$$P_{dj}^{1-\sigma} = \gamma \sum_{o} N_{oj} \left(\frac{\sigma}{\sigma - 1} \frac{w_o \left(R_{oj} \right)^{\bar{\tau}_j}}{A_{oj}} d_{odj} \right)^{1-\sigma}$$

- Zero-profit condition

$$w_o f_{oj} N_{oj} = \frac{1}{\sigma} \sum_{d} X_{odj}$$

- Balanced trade

$$w_o L_{oj} = \sum_{d} \sum_{m} \left[\frac{\sigma - 1}{\sigma} \left(R_{oj} \right)^{-\tau_j^1 - \tau_{odjm}} + \frac{1}{\sigma} \right] s_{odjm} X_{odj}$$

- Interest payments:

$$I_{oj} = \sum_{d} \sum_{m} \frac{\sigma - 1}{\sigma} X_{odj} s_{odjm} \left[1 - \left(R_{oj} \right)^{-\tau_j^1 - \tau_{odjm}} \right]$$

Note that the expression for sectoral trade costs or *average export cost* between locations o and d, d_{odj}, is given by equation (10).

4.3.1 Equilibrium in changes

To reduce the number of parameters that we need to calibrate or estimate, such as productivity A_{oj} or mode-specific trade costs d_{odjm}, we reformulate the equilibrium conditions in changes as in Dekle et al. (2007). We denote proportional changes between the new and the old equilibrium as $\hat{X} = \frac{X^{new}}{X^{old}}$. Thus, we can solve for changes in average trade costs $\hat{d}_{odj}$, trade flows $\hat{X}_{odj}$, prices $\hat{P}_{dj}$, wages $\hat{w}_o$ and firm entry $\hat{N}_{oj}$:

$$\hat{d}_{odj} = \left(\sum_{m} \left(\frac{\left(\hat{R}_{oj} R_{oj} \right)^{\hat{\tau}_{odjm} \tau_{odjm}}}{\left(R_{oj} \right)^{\tau_{odjm}}} \hat{d}_{od,jm} \right)^{-\mu} s_{od,jm} \right)^{-\frac{1}{\mu}} \tag{13}$$

$$\hat{X}_{odj} = \hat{N}_{oj} \left(\frac{\hat{w}_o \left(\hat{R}_{oj} \right)^{\bar{\tau}_f}}{\hat{A}_{oj}} \hat{d}_{odj} \right)^{1-\sigma} \frac{\hat{X}_d}{\hat{P}_{dj}^{1-\sigma}} \tag{14}$$

$$\hat{P}_{dj}^{1-\sigma} = \sum_{o} \pi_{odj} \hat{N}_{oj} \left(\frac{\hat{w}_o \left(\hat{R}_{oj} \right)^{\bar{\tau}_j}}{\hat{A}_{oj}} \hat{d}_{odj} \right)^{1-\sigma} \tag{15}$$

$$\hat{w}_o \hat{f}_{oj} \hat{N}_{oj} = \sum_d \frac{X_{odj}}{X_{oj}} \hat{X}_{odj} \tag{16}$$

$$\hat{w}_o \hat{L}_o = \sum_d \sum_j \sum_m \left[\frac{\sigma - 1}{\sigma} \left(\hat{R}_{oj} R_{oj} \right)^{\bar{\tau}_j + \tau_{odjm}} + \frac{1}{\sigma} \right] \frac{X_{odj}}{w_o L_o} \hat{X}_{odj} \hat{s}_{odjm} s_{odjm} \tag{17}$$

$$\hat{X}_o = \sum_j \sum_d \frac{\alpha_{dj} \pi_{odj} X_d}{X_o} \hat{X}_{odj} \tag{18}$$

where π_{odj} is the initial equilibrium's trade share $X_{odj} / \sum_n X_{ndj}$. Equations (13) to (17) allow us to solve for the change in equilibrium based on data on initial modal shares ($s_{od,jm}$), trade shares (π_{odj}), sectoral shares ($\frac{X_{odj}}{w_o L_o}$) and destination output shares ($\frac{X_{odj}}{X_{oj}}$), as well as initial gross interest rates R_{oj} and elasticities $\sigma - 1$ and μ.

4.4 Calibration

In addition to sectoral and trade shares, the following parameters have to be calibrated: the trade elasticity ($\sigma - 1$), the sector-specific time-to-build ($\bar{\tau}_j$), the initial gross interest rate (R_j) and the shipping mode elasticity μ.

We use estimates of the trade elasticity from the literature, and calibrate sectoral and trade shares directly from the data. For interest rates, we use the US real interest rate 2012-19 average for $R^* = 1.02$, and set the rest of the world's premium ($\bar{R}_{ROW}$) to 0, while we set $\bar{R}_{COL}$ to match the average Colombian real interest rate of 1.08. Sectoral rate premiums are set based on the observered average rates in the *Super Sociedades* data.

We calibrate the sector-specific time-to-build ($\bar{\tau}_j$) to match the aggregate short-term debt interest payments to total variable cost in the *Super Sociedades* data. Appendix D.1 describes the exact procedure.

Our sectoral breakdown corresponds to slight aggregates of the ISIC 2-digit classification, so that the model is composed of two regions (Colombia and a rest of the world composite), 32 sectors (mostly manufacturing) and 2 modes of transportation (sea and other). Table 5 describes the source of our calibration. The only parameter remaining to estimate is the shipping mode elasticity that we estimate below.

Table 5: Calibration summary

Object	Description	Value	Source
π_{odj}, $\frac{X_{odj}}{w_o L_o}$, $\frac{X_{odj}}{X_{oj}}$	Trade and sectoral shares		ICIO (OCED)
$s_{od,jm}$	Modal share		Customs data
$\bar{\tau}_j$	Time to build (in years)	[0, 1.09]	Supersociedades
R^*	World interest rate	1.02	World Bank (US)
$\bar{R}_o$	Interest rate	$\bar{R}_{ROW} = 0$, $\bar{R}_{Col} = 0.0612$	World Bank
ρ_j	Sectoral rate	$[-0.028, 0.034]$	Supersociedades
$\sigma - 1$	Trade elasticity	4	Literature
τ_{odjm}	Shipping time	$\tau_{SEA} = 3.5/12$, $\tau_{AIR} = 0$	Table 3
μ	Mode elasticity	4	Own estimate

Note: The table displays the calibrated values for parameters and the data sources.

4.4.1 Shipping mode elasticity

To estimate μ, we start from equation (9) on the modal share reproduced below for convenience, adding the time dimension we also have in the data:

$$s_{odjm_t} = \frac{\left((R_{oj,t})^{\tau_{odjm}} d_{odjm} (a_{jm,t})^{\frac{1}{1-\sigma}} \right)^{-\mu}}{(d_{odj,t})^{-\mu}}$$

$$s_{odjm,t} = \exp\left(-\mu \times \tau_{odjm} \ln R_{oj,t} - \mu \ln d_{odjm} + \frac{\mu}{\sigma - 1} \ln a_{jm,t} + \Phi_{odj,t} \right)$$

Focusing on Colombian data, we drop the o subscript and parametrize the trade cost and taste shifter as a djm fixed effect to get the following estimation equation

$$s_{odjm,t} = \exp\left(-\mu \times \tau_{djm} \ln R_{oj,t} + \eta_{djmt} + \gamma_{djt} \right). \tag{19}$$

The remaining hurdle is to specify τ_{djm}, the amount of time before the firm receives payment for a shipment by mode m. Since our model is calibrated to Colombia and the rest of the word, we simply use a dummy variable for sea shipments, and interpret the magnitude based on the delay in payment documented above.

Table 6 shows the results of estimating equation (19) using a Poisson PML estimation. The first two columns simply use a dummy variable for sea instead of τ_{odjm}, so that the coefficient should be interpreted as the elasticity of mode-switching $-\mu$ multiplied by the average time difference when receiving payment for sea versus other shipments. Hence, the coefficient of 1.2 implies an elasticity $\mu = 1.2/(3.5/12) \approx 4$ given that sea exports seem to be paid about 3.5 months after air exports (Table 3). The estimate in column 2 also includes a destination-mode-time fixed effect that could capture any time varying demand shift for a particular mode or any overall change in shipping cost for that mode.

Table 6: Mode switching elasticity estimation

	Modal share ($s_{Col,djmt}$)			
$1_{m=AIR} \times \ln R_{ojt}$	1.286**	1.431**		
	(0.443)	(0.583)		
$\texttt{time}_{Col,md} \times \ln R_{ojt}$			-24.55***	-35.83*
			(10.07)	(20.57)
Observations	155722	144982	144992	129844
Control for $1_{m=AIR} \times \ln \frac{\texttt{value}}{\texttt{weight}}$	✓	✓	✓	✓
odjt and *odjm* FE	✓	✓	✓	✓
odmt FE		✓	✓	✓
ojmt FE				✓

Note: $\texttt{time}_{Col,d}$ is set to 1/365 for air shipments and $n_d/365$ for sea shipments, where n_d is the number of days take for a ship to reach d from Colombia. Standard errors are clustered at the sector-mode-time level.

To our knowledge, there are only two estimates of the elasticity of substitution between modes. First, Fuchs and Wong (2024) obtain an elasticity estimate of 1.099 for rail and truck modes in the U.S. Second, Tolva (2024) estimates an elasticity of 1.58 for air and sea. Our estimate is higher, and section 5.2 explores the sensitivity of our model results to the value of μ.

As a robustness check, in columns 3 and 4, we instead measure τ_{odjm} as the number of days ships take from Colombia to destination d's main port (or closest port for inland destination). As expected, the coefficient is negative and significant, indicating that shipments by sea are less likely when interest rates are higher, especially for destinations that take more time to reach. Column 4 even includes an sector-mode-time fixed effect, thus only using variation in time to ship across across destination.[19]

5 Counterfactual: Improving access to finance

We use the model to study the impact of two hypothetical scenarios. First, we remove the financing wedges faced by Colombia relative to the rest of the world. In this scenario, we exogenously reduce R_{oj} for all sectors in Colombia. The solid yellow line on Figure 2 displays the results for a variety of interest rate decreases. The vertical axis depicts the change in aggregate air share for each decrease in interest rate. When interest rate decreases by 7 pp

[19] If our measured shipment time was equal to the time delay in receiving payment, one could interpret the coefficients directly as the mode-switching elasticity. However, we refrain from doing so as the time of shipment is measured with error and we can instead rely on the direct evidence on average delay in payments received by mode.

(about the gap between Colombia and US interest rates), the share of air shipments decreases by around 1.2 pp, from of a base share of 27% in value.

We decompose the change into a within-sector change and a between sector reallocation change defined as follows:

$$s_1^{AIR} - s_0^{AIR} = \sum_j \underbrace{\frac{\lambda_j^0 + \lambda_j^1}{2}}_{\text{export share}_j} \underbrace{\left(s_{odj,AIR}^1 - s_{odj,AIR}^0\right)}_{\text{change within sector}} + \sum_j \underbrace{\left(\lambda_j^1 - \lambda_j^0\right)}_{\text{between/reallocation}} \underbrace{\frac{s_{odj,AIR}^1 + s_{odj,AIR}^0}{2}}_{\text{avg air share}_j}$$

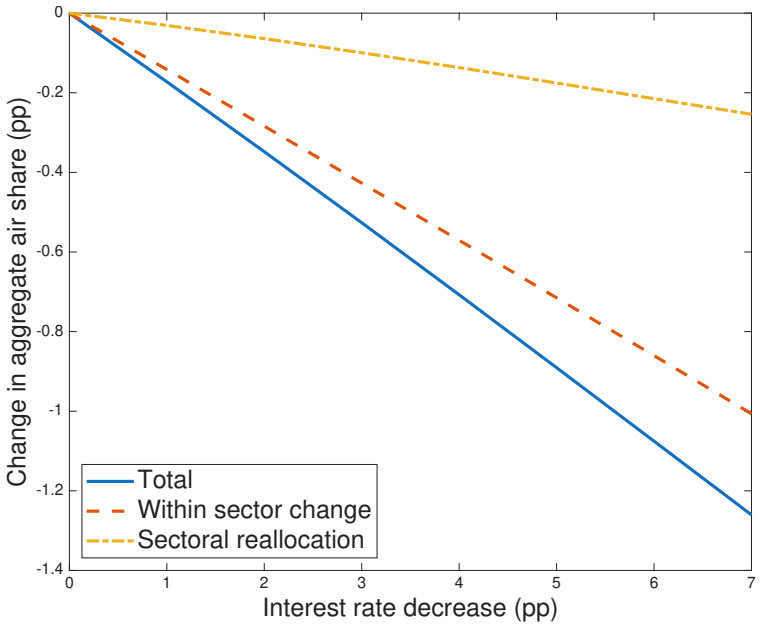
Within a sector, the modal share shifts away from air because sea shipments become relatively cheaper to finance in advance. In addition, the decrease in the interest rate impacts relative sectoral sizes through two channels. First, it lowers the cost borne by sea exporters so that the sectoral composition of exports shifts towards sea-intensive sectors. Second, it lowers the financing cost borne by sectors with long time to build $\bar{\tau}_j$, thereby shifting the composition of exports towards high $\bar{\tau}_j$ sectors. Whether this increases or decreases aggregate air share depends on the correlation between $\bar{\tau}_j$ and air-intensity, a question we return to below.

Figure 2 plots the total change in aggregate air share (blue solid line) and its decomposition into the within (dashed red) and between (dash-dot yellow) sector channels. The within channel decreases air usage and accounts for the majority of the drop.

The between sector channel is also negative, indicating that a decrease in interest rate tends to reallocate exports towards sea-intensive sectors. As mentioned above, the sectoral reallocation is driven by two effects: the relative increase in sea-intensive sectors and the relative increase in high-$\bar{\tau}_j$ sectors. To disentangle the two effects, we run two additional exercise. We rerun the same counterfactual interest rate decrease, but shut-down each channel at a time. First, we shut down the heterogeneity in time to build across sectors and set $\bar{\tau}_j$ equal to the average. This isolates the sectoral reallocation coming from the relative decrease in sea-intensive sector export costs. Second, we shut down the asymmetry between air and sea shipping cost by setting $\tau_{odj,sea} = \tau_{odj,air} = 0$. This isolates the sectoral reallocation coming from heterogeneity in exposure to financing costs due to the production technology.

Figure 3 plots the between decomposition in the two cases, in addition to the original decomposition. The dash-dot yellow line corresponds to the total between effect, similar to the dash-dot yellow line in Figure 2. The red solid line is decreasing and shows that sectoral reallocation towards sea-intensive sectors would be higher if only the change in air vs sea export costs were at play. The dashed blue line is increasing, implying that sectors with larger $\bar{\tau}_j$ are actually more air-intensive. This is consistent with with Harrigan (2010) evidence that lighter, higher-value goods are disproportionately shipped by air and with

Figure 2: Aggregate air share and interest rate



Note: In this figure, we display the results of multiple counterfactual scenarios in which we reduce the interest rate faced by all Colombian sectors. For each counterfactual, each point represents the change in aggregate air share of Colombia's exports (y-axis) when we reduce the interest rate by a specific amount measured in percentage points (x-axis).

Hummels and Schaur (2013) finding that sectors with high time costs rely more on fast air transport.[20] Appendix Figure 13 shows that the correlation between $\bar{\tau}_j$ and air share is indeed positive.

5.1 Drivers of comparative advantage evolution

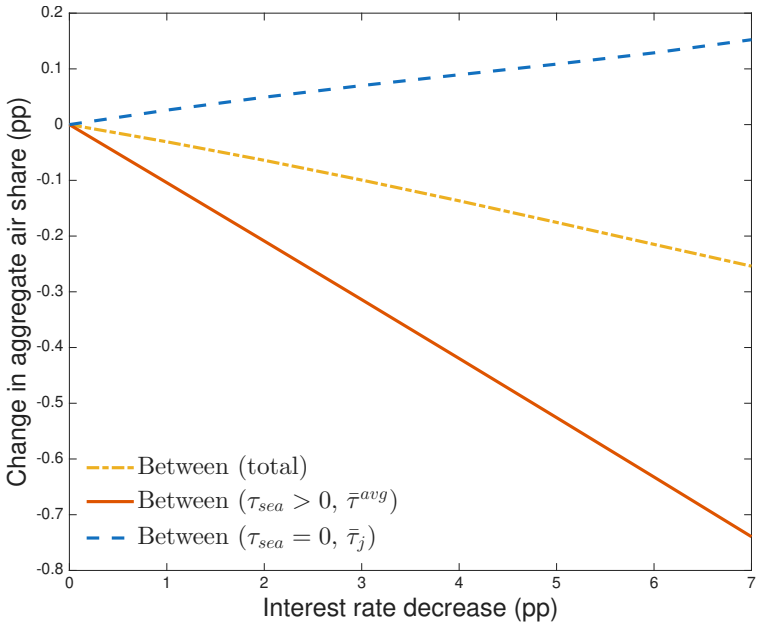
The results above imply that the two channels have an opposite impact on sectoral reallocation. The impact on aggregate air share is dominated by the fact that sea-intensive sectors expand, but the impact on overall sectoral composition can go the other way.

To uncover the relative importance of drivers of the overall shift in sectoral composition of Colombia's exports in the counterfactual, we compute the change in the Balassa Relative Comparative Advantage Index for each sector when the aggregate interest rate in Colombia decreases by 7%. We then regress it on the two main sources of sectoral heterogeneity: baseline sea intensity and overall sectoral exposure to finance through the time to build.

Table 7 displays the results of these regressions. The first column shows that there is no

[20] In our model, there is no mechanical relationship between $\bar{\tau}_j$ and air intensity because the financing cost for production operates regardless of the mode of shipment. From the point of view of the model, this positive correlation between $\bar{\tau}_j$ and air share can be rationalized by a positive correlation between $\bar{\tau}_j$ and the sector-mode specific shipping costs $d_{odj,sea}/d_{odj,air}$ or sector-mode specific taste shifters $a_{j,air}/a_{j,sea}$.

Figure 3: Between-sector reallocation and air share



Note: The dash-dot yellow line corresponds to the total between effect, similar to the dash-dot yellow line in Figure 2. The solid red-line corresponds to the between effect when all sectors have the same $\bar{\tau}_j$

unconditional correlation between change in RCA and sea share. On the contrary, there is a positive and significant correlation between change in RCA and exposure to finance (column 2). However, this doesn't mean that the sea intensity doesn't matter for the evolution of comparative advantage. When including both regressors, the correlation with initial sea share becomes significant and positive, and the correlation with $\bar{\tau}_j$ is strengthened. As Figure 13 in the appendix documents, it turns out that $\bar{\tau}_j$ is negatively correlated with sea intensity. High-finance dependent sector (those with large $\bar{\tau}_j$) tend to ship more by air.

In terms of magnitude, the time-to-build sectoral heterogeneity explains the larger share of the variance in revealed comparative advantage. It can account for 74% of the variance in RCA by itself, while adding the sea-intensity channel improves this to 82%, implying a partial R-square of 8%. Overall, this suggests that the importance of the sea-intensity channel is still sizable, at about 10% of that of the well-established channel of finance exposure.

5.2 Sensitivity to the mode switching elasticity

One of the key parameter of the model is the mode-switching elasticity μ. That parameter governs to a first order how much the air share within a sector reacts to a change in interest rate. However, the sectoral reallocation is only affected by μ through a second-order.

Figure 4 illustrates this, by plotting the change in aggregate air share for different values of μ. The sectoral reallocation ("between") channel is largely unaffected and would operate

Table 7: Channels of change in comparative advantage when decreasing interest rate

	Change in RCA		
Initial sea share ($s_{Col,ROW,j,sea}$)	-0.0271		0.080***
	(0.047)		(0.022)
Time to build ($t\bar{a}u_j$)		0.267***	0.308***
		(0.029)	(0.027)
R2	0.01	0.74	0.82
N	32	32	32

Note: The table reports the results from regressing the change in sectoral RCA on the initial sea share and the time to build parameter ($\bar{\tau}_j$. All regressions are weighted by initial export value.

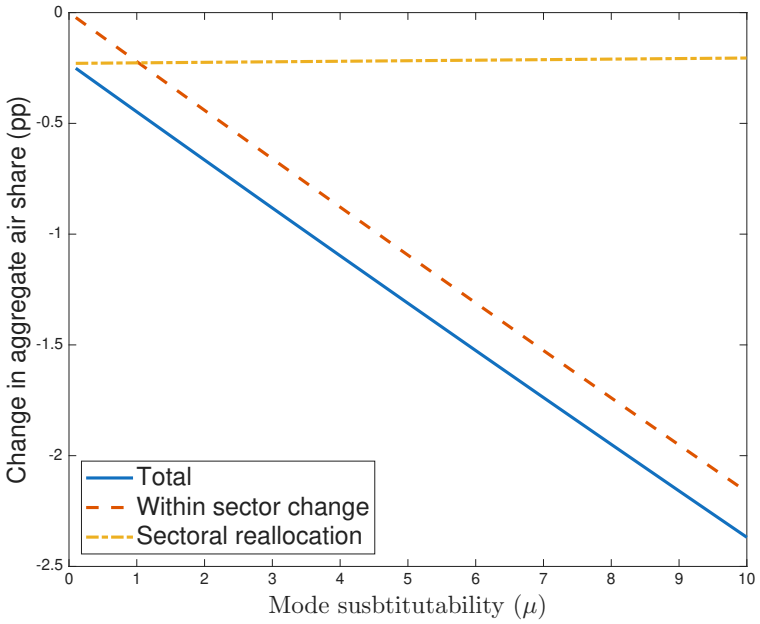
even in the absence of any switching. On the other hand, the within-sector channel is increasing in μ.

5.3 Environmental implications

As emphasized in Lugovskyy et al. (2025), the substitutatbility between air and sea shipping can matter for pollution, as air shipping is much more CO_2 intensive. Our findings imply that a fall in interest rate could reduce air shipping and increase sea shipping, thereby decreasing overall CO_2 emissions. On the other hand, the sectoral reallocation channel is ambiguous as the previous section implies a potentially large reallocation towards air-intensive sectors due.

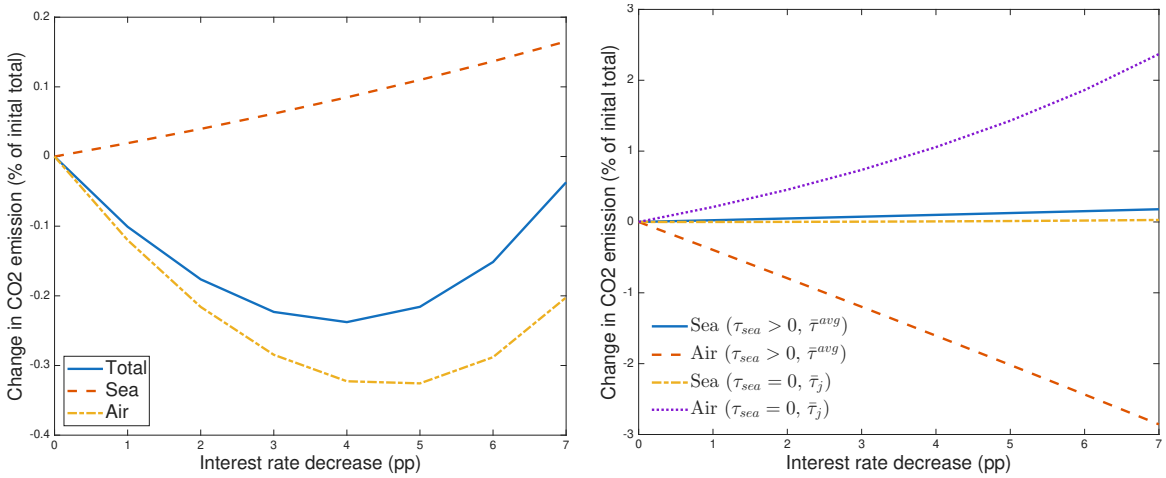
We investigate this in our model and compute the change in CO_2 emissions from Colombian exports caused by a decrease in interest rates, assuming that ocean transportation emits 103.5 times less CO_2 than air shipping (Lugovskyy et al., 2025). Figure 5 plots the change, decomposed in to emissions from air and sea shipment. The magnitude of the change is small, at around 0.2%. Overall sea emissions increase, as exports increase and firms shifts towards sea. The impact on air emissions is U-shaped. At first, they decrease as air shipments are replaced by sea shipments. However, as sectoral reallocation towards high $t\bar{a}u_j$ sectors happen, air emission increase because those sectors tend to be air-intensive. The right panel illustrates this point. When shutting down the shift towards high $t\bar{a}u_j$ sectors (dashed red line), emissions would drop by an order of magnitude more. Note that even if at the 7% interest rate decrease, the net impact on emission is null, exports themselves are increasing thanks to the decrease in export cost and the decrease in production cost, so that emission per export are still decreasing.

Figure 4: Importance of mode switching elasticity



Note: The figure shows the impact of reducing the aggregate Colombian interest rate from 8.2% to 2% for different values of μ.

Figure 5: CO2 emissions and interest rate decrease



Note: The left figure shows the estimated change in CO2 emissions following a decrease in Colombian interest rate, decomposed into the change coming for air and sea shipments. The right panel further decompose the change in air emissions isolating the reallocation towards sea-intensive sectors (red dash) vs high time-to-build sectors (dotted purple).

6 Conclusion

The paper shows that transport-mode–specific payment lags are a first-order determinant of how finance shapes trade patterns. Using Colombian data that link banks, firms, exports, and export payments, we document that sea shipments entail substantially longer payment lags than air shipments and that better access to bank credit tilts firms away from air freight and toward sea. We also show that improving access to finance reduces the likelihood of shipping by air. Using a two-country model of international trade with external financing and transportation choices, we show that payment lags affects sectoral specialization and comparative advantage, with sea-shipping payment lags accounting for about 10 percent of the impact of improved financial access. Importantly, sectors that are both credit-intensive and reliant on slow sea shipping thus stand to gain the most from better export financing, suggesting that policies targeting working-capital support toward sea-reliant, long-production-cycle, high-value sectors can shift comparative advantage in their favor.

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Online Appendix

Appendix A Data

A.1 Customs Data: Exports

All export shipments must be reported to the Colombian Tax and Customs National Authority (DIAN). This report contains detailed information on the shipment and the exporter at the transaction level, including data on the good, weight, mode of transportation, firms and cities of origin and destination, and the value of export. We use data issued between January 2008 and December 2019 for firms with a valid firm identifier, where we define an incorrect identifier for having fewer than six digits or being non numeric.

We further clean city names in order to accurately assign geographic coordinates and standardize city information. To do this, we eliminate non-alphabetic characters and common non-city terms, followed by a harmonization against a global reference lists of recognized cities. We apply deduplication and string normalization methods, including both direct and fuzzy matching approaches, to link export city-country pairs to the international cities dataset. For cases where automated matching was insufficient, a combination of country-specific rules and manual assignments ensured that all cities were accurately matched to their standardized forms.

To organize the transaction-level data in a monthly panel, we remove observations for which the destination country is Colombia or a free trade zone. Since there could be modifications, addendum, or anticipated declarations, we only keep final ordinary exports and the first time of declaration. Finally, we have a monthly exports panel that contains the number of units shipped, export value, packing, and weight, in addition to the transport mode, payment method, origin and destination locations, customs information, and product type, defined as the mode within a month.

A.2 Exports' payments

All foreign exchange declarations for export transactions are reported to Colombia's Central Bank (Banco de la República) in format 2 of the international transactions data. This report contains information on the exporter and the exchange operation, including each payment that an exporter firm received, and the bank through which the transaction was realized. The data contains export transaction payments including foreign and local currency payments, credit card and payment facilitator transfers, payments from major commodities like coffee and petroleum, duty-free zone payments, trade credit, advance payments, expenses, in-kind settlements, commissions, deductions, and devolutions. We use the data reported between January 2008 and December 2022.

We created a monthly panel using this data. To this end, we keep the current informa-

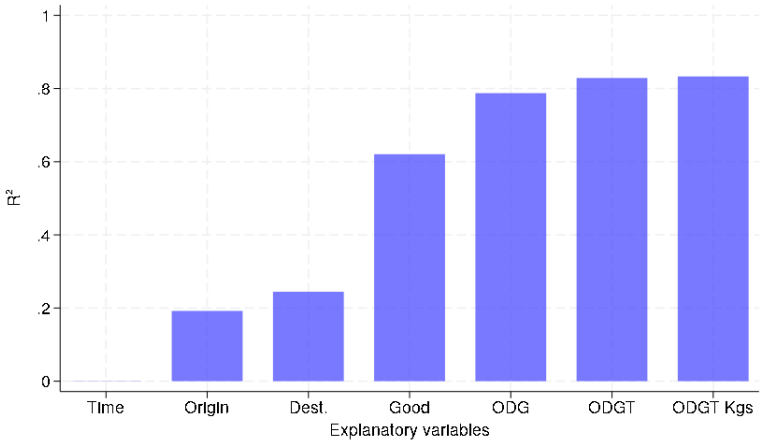
tion of the exchange declarations, which reflects the last update on the transaction, since there could be modifications or withdrawals. Additionally, we keep only the first time of declaration and remove negative values from the reported cash payments. As with the rest of the data sources, we keep only the information for firms with the Colombian firm identifier "NIT" and, in this case, we keep the firms that engaged in trade. To create the monthly panel, we summed each type of payment by firm and generated the bank and sector's mode.

Finally we merged monthly panel data on export payments with the customs monthly panel. With this dataset, we are able to identify the first and second instances in which each firm exported. Next, we balance the panel and subject it to a series of filters: (1) Firms with total exports or total payments equal to zero are excluded. (2) Trade credit and main payments recorded prior to the first export are replaced with zero, as such payments should, by design, occur after the export event. (3) Firms with recorded payments one year prior to the first export are dropped, as these likely reflect misreporting. (4) Payments are retained within a window of six months before and twenty-four months after the first export. (5) Firms with exclusively advance payments are excluded. (6) Firms for which received payments exceed the value of the export at the time of first export are removed. (7) Firms that exported only once are excluded due to potential outlier behavior. For the event study, we construct two payment measures from the data: total payments, defined as the sum of anticipated, short-term, and long-term payments; and main payments, which comprise only short-term payments.

Appendix B Additional Facts

Figure 6 examines how well shipment characteristics typically associated with the "nature" of exports—such as origin, destination, and product—explain firms' probability of exporting by air. We regress this probability on these shipment-specific fixed effects and track the R-squared. The fact that the R-squared never approaches one indicates that these observable traits alone cannot fully account for the decision to ship by air. This leaves a substantial unexplained margin, suggesting the presence of unobserved factors that influence transport mode choice. We argue that one key driver partially filling this gap is financial constraints faced by firms, which motivates this paper's analysis.

Figure 6: Nature cannot explain all air shipments



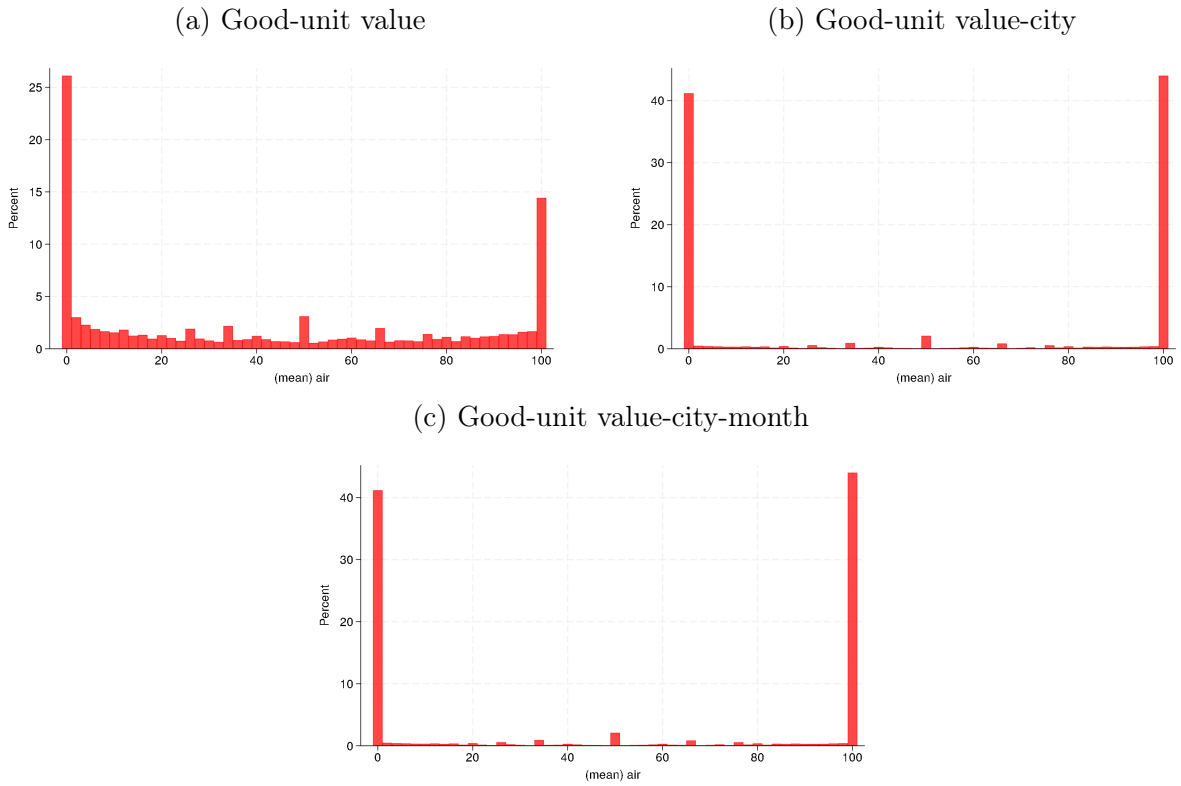
Note: Each bar shows the R^2 of regressing the probability of shipping by air in a set of controls. From left to right the regressions include: Time fixed effects, city of origin fixed effects, city of destination fixed effects, goods at the HS6-digit level fixed effects, City of origin-destination-good fixed effects (ODG), City of origin-destination-good-time fixed effects (ODGT), and City of origin-destination-good-time fixed effects and weight in kilograms by shipment (ODGT Kgs).

B.1 Additional facts on air intensity by good

Figure 7 complements the evidence offered in Section 3 by summarizing the distribution of air at a more disaggregated level. Panel A shows the distribution for goods with similar unit values, while Panel B focuses on shipments with a comparable value arriving in the same destination city. The results show that, even when controlling for these very specific characteristics, there is still a substantial within-good substitutability: a large share of observations exhibit intermediate air use. This finding reinforces the main text's argument: even for identical products and routes, firms act upon a range of incentives and constraints that drive heterogeneity in export mode selection.

Additionally, Figure 8 complements the previous histogram by displaying the cumulative share of air shipments across several dimensions: transactions, goods, value, CO2 emissions, and weight. The graph evidences considerable heterogeneity on air usage across different shares, but it consistently lies between zero and one for all measures. This persistent mix

Figure 7: Good transport mode mix controlling for unit value and city of destination



Note: Histograms display the distribution of air intensity across goods exported in Colombia using HS6-digit classification. In Panel A, we control for good's unit value. In Panel B we control for city fixed effects, in addition to unit value. Air intensity is computed as the share of transactions within good that use air. Data Source: DIAN and author's elaboration.

suggests that firms do not uniformly select a single transport mode along any dimension, even after controlling for detailed observable characteristics.

B.2 Additional facts on payment delay

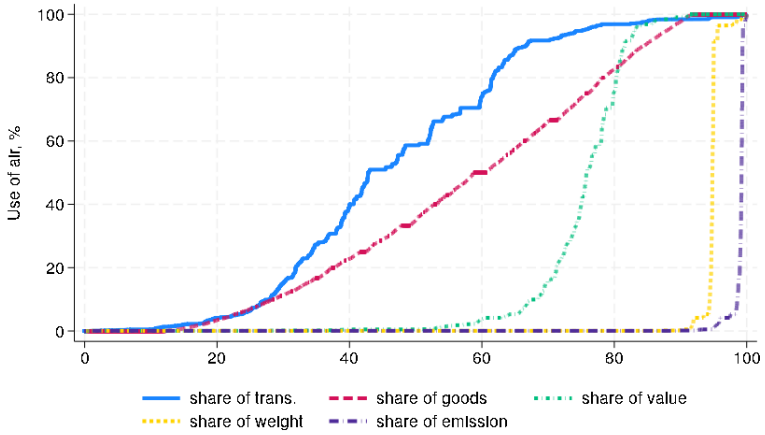
To complement the results in Section 3, we first confirm that firms shipping by air and by sea are equally likely to receive advance payments. Table **??** reports the difference in the share of firms receiving advance payments between sea and air shipments, and shows that this difference is not statistically significant.

Then, we expand the results on Table 3 by including in the estimation sample any shipment happening at least a year after the previous shipment. In this regard, Table 9 similarly shows a negative and significant coefficient, consistent with the results found in the main part of the paper.

Finally, we estimate an alternative specification by interacting the dummy for whether the export was made by air ($\texttt{LastAir}_i$) with sea shipping time. Table 10 show statistically significant coefficients for the interaction term, with magnitudes and signs that align with the findings on Table 3.

We also estimate an event-study design to characterize the dynamics of export payments

Figure 8: Air proportion of air shipments using different measures



Note: The vertical axis shows the proportion of air usage. The blue solid line shows the share of transactions, the dashed red line shows the share of goods, the dashed-dotted green line shows the share of value, the dotted yellow line shows the share of CO2 emissions, and the long-dashed-dotted purple line shows the share of weight. Data Source: DIAN and author's

Table 8: Air-exporting firms more often get paid in shipment month, but advanced payment rates are similar across modes

Variable	Sea	Air	Difference
Paid in advance	0.737	0.739	0.001
	(0.48)	(0.50)	

Note: This table reports the average difference in the share of firms, by transport mode (sea vs. air), that receive payments in advance or within the same month as export. We show standard errors in parenthesis and the significance level of the difference: *** p<0.01, ** p<0.05, * p<0.1.

following a firm's initial entry into foreign markets. Our identification strategy exploits variation in the timing of firms' first export, allowing us to trace how payments evolve in the months before and after this event.[21] Formally, we estimate the following specification:

$$Y_{jmt} = \beta_0 + \sum_{s=-3}^{12} \beta_{ms} D_{jm,t-s} + X'_{jtm}\beta + \alpha_j + \alpha_t + \epsilon_{jmt}, \tag{B.1}$$

where Y_{jmt} denotes the dollar value of export payments received by firm j , shipping by mode m, in month t. The variable $D_{jm,t-s}$ s an event-time indicator equal to one if month t is s months relative to the first export (with $s = 0$ denoting the first shipment). Motivated by the data, which show that payments often occur up to a quarter before the recorded

[21] As a robustness check, Appendix 10 reports results using the second export event as the reference point. Each specification entails a trade-off. Using the first export provides cleaner identification of payment dynamics but offers limited scope for additional controls, as many firms export only once. Using the second export increases variation and allows for richer controls, such as destination and product, though at the cost of weaker identification of the initial timing of payments.

Table 9: Air shipment share and payment delay estimates

	Time since last export shipment ($\texttt{delay}_i$)		
	(1)	(2)	(3)
$\texttt{LastAir}_i$	-1.949**	-1.203*	-0.888*
	(0.829)	(0.621)	(0.522)
$\ln \texttt{value}_i$	-0.712**	-0.739***	-0.894***
	(0.293)	(0.247)	(0.164)
Observations	8513	14061	8513
Date FE	✓	✓	✓
Gaps FE	✓	✓	✓
HS6 FE	✓	✓	✓
Destination FE	✓	✓	✓

Note: This table displays the results from estimating equation (2) with an expanded sample, that includes any shipment happening at least a year after the previous shipment. All regressions are weighed by export value. Standard errors are clustered at the month level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

first export, we allow for leads of up to three months. We also track payments for twelve months following the event. We include as controls, X_{jtm} the value of subsequent exports (to isolate dynamics specific to the initial export). We also include firm (α_j) and time (α_t) fixed effects.[22]

To isolate systematic differences in payment delays across transport modes, we restrict the sample to firms that export exclusively by sea or exclusively by air and we estimate two separate regressions, one for each shipping mode, and recover distinct sets of event-time coefficients β_{ms}, and show them in figure 9. Panel (a) reports results for air shipments, while Panel (b) reports results for sea shipments. The vertical axis plots the estimated coefficients, and the horizontal axis denotes event time s, measured in months relative to the first export. We omit the month immediately preceding the first export, so all coefficients are interpreted relative to that baseline period.

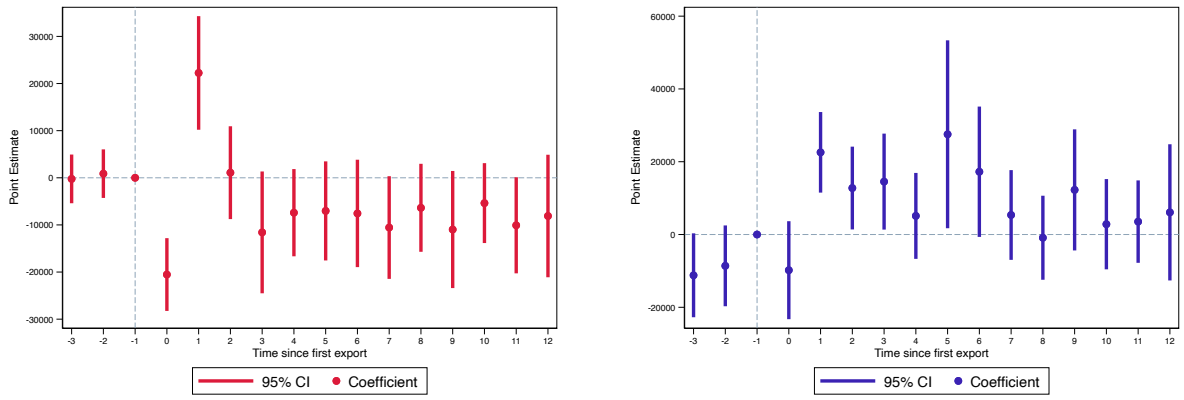
Our results show that firms shipping by air receive their payments between one month before and up one month after they export, while firms shipping by sea receive payments during the first two quarters after the export, with an up-think during months five and six. It is relevant to mention that all other coefficients are not statistically significant, reinforcing the idea that firms do not receive disproportionally more anticipated payments. This results suggests that access to credit might be fundamental in choosing the mode of transportation given that there is a mismatch between the shipment and the payments. Firms with more access to credit could afford a cheaper yet slower mode of transportation, while firms without access to credit will need to choose a more expedite more – air– in order to finance their obligations.

[22]When using the second time a firm exports, we can control by the main product exported in a given month, and the city of destination.

Figure 9: Payment delays are longer for sea shipments than for air shipments

(a) Air

(b) Sea

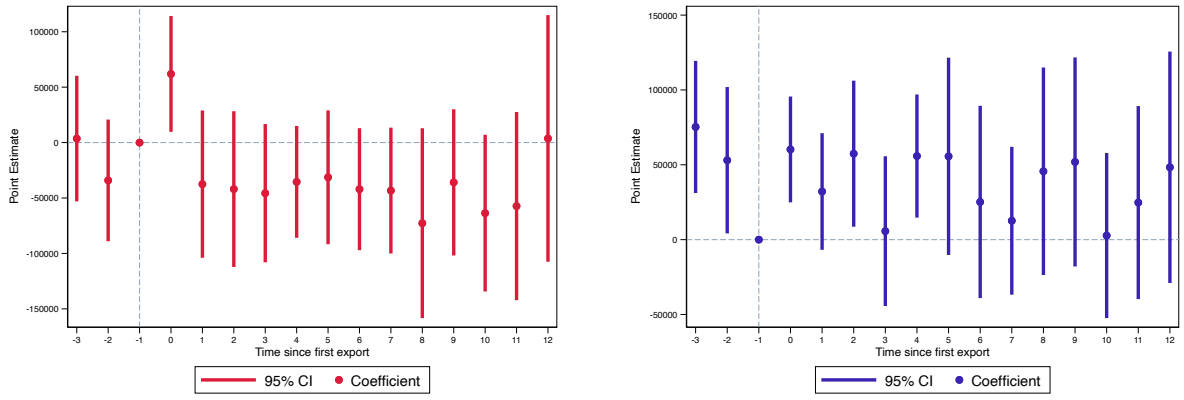


Note: This figure plots the estimated coefficients β_{ms} from equation B.1. The vertical axis measures the dollar change in export payments relative to the month prior to the first shipment, while the horizontal axis reports event time in months before and after the initial export. Panel (a) (left) displays results for air shipments (red dots), and Panel (b) (right) displays results for sea shipments (blue dots). Vertical bars denote 95% confidence intervals based on robust standard errors clustered at the firm-month level. The air-shipment regression is estimated with 222,541 observations, and the sea-shipment regression with 166,711 observations.

Figure 10: Payment delays are longer for sea shipments than for air shipments using the second export

(a) Air

(b) Sea



Note: This figure plots the estimated coefficients β_{ms} from equation B.1 and adding mode good and city of destination fixed effects. The vertical axis measures the dollar change in export payments relative to the month prior to the second shipment, while the horizontal axis reports event time in months before and after the initial export. Panel (a) (left) displays results for air shipments (red dots), and Panel (b) (right) displays results for sea shipments (blue dots). Vertical bars denote 95% confidence intervals based on robust standard errors clustered at the firm-month level. The air-shipment regression is estimated with 222,541 observations, and the sea-shipment regression with 166,711 observations.

Table 10: Air shipments share interacted with sea shipping time

	Time since shipment ($\texttt{delay}_i$)		
$\texttt{SeaTime}_i$	-0.461***	-0.423***	-0.314***
	(0.072)	(0.057)	(0.072)
$\texttt{SeaTime}_i \times \texttt{LastAir}_i$	-0.878***	-0.782***	-0.534***
	(0.261)	(0.231)	(0.194)
$\ln \texttt{value}_i$	-1.266***	-1.138***	-0.530**
	(0.178)	(0.159)	(0.262)
Observations	8880	8875	8511
t FE	✓	✓	✓
Time to next shipment FE		✓	✓
HS6 and destination country FE			✓

Note: This table displays the results from estimating equation (2) interacted with the shipping time by sea relative to air. All regressions are weighed by export value. Standard errors are clustered at the month level.

Appendix C Robustness

In this section, we present several exercises that confirm the robustness of our empirical findings. First, we examine whether access to finance on the extensive margin fully explains the shifts in the probability of using air, rather than the intensive margin measures explored in Section 3. Finding a prevalence of the extensive margin in changing the probability of shipping goods by air would imply that entry into the credit market plays a higher role than the intensity of credit usage on transportation choices. Formally, we estimate the following specification:

$$\begin{aligned} \text{Air}_{odgjts} = \beta_0 + \beta_1 \text{BankAccess}_{jt} + \sum_k \beta_k \, \text{CreditMeasure}_{jt} \cdot \text{BankAccess}_{jt} \\ + \beta_3 \log(\texttt{unitValue})_{odgjt} + \alpha_{ts} + \alpha_{odgt} + X'_{jt}\beta + \epsilon_{odgjts} \end{aligned} \tag{C.1}$$

where BankAccess_{jt} is a dummy equal to one if firm j has at least one active loan on year t and $\text{CreditMeasure}_{jt}$ includes the intensive margin measures analyzed in Section 3. The rest of the equation's elements are homologue to the ones in Equation (3). Table 11 reports the results and reveals that bank access on the extensive margin does not significantly alter the probability of using air transport. The interaction between bank access and intensive margin measures, on the other hand, are consistent with the ones found in Table 11, reinforcing the conclusion that greater access to finance substantially reduces the likelihood that firms use air mode.

We then estimate how the effect of sea shipping time on the probability of using air depends on firms' access to bank credit, using IV to purge the credit variables of endogeneity. With this specification, our aim is to test whether credit conditions still shape transport choices even after directly controlling for a key transaction characteristic—how long it takes to ship by sea—and thus complements the main analysis by ruling out that sea time alone explains the shift from sea to air. Table 12 shows that the coefficients of the interaction-

Table 11: Higher access to banking credit reduces the probability of shipping by air

	(1)	(2)	(3)	(4)
Bank access dummy	-0.016	-0.009	-0.017	-0.008
	(0.018)	(0.018)	(0.018)	(0.018)
Bank access * Int. payments to sales	-0.026***			
	(0.009)			
Bank access * Int. rate		0.007*		
		(0.003)		
Bank access * Total debt			-0.011***	
			(0.003)	
Bank access * More loans				-0.011**
				(0.005)
Unit value	0.021***	0.021***	0.021***	0.021***
	(0.002)	(0.002)	(0.002)	(0.002)
Origin-Dest-Good-Month FE	✓	✓	✓	✓
Year_Sector FE	✓	✓	✓	✓
Firm level Controls	✓	✓	✓	✓
R^2	0.760	0.760	0.760	0.760
N	4,568,834	4,568,834	4,568,834	4,568,834

Note: This table shows the extensive margin results for the probability of shipping by air. Bank access dummy is equal to one if firm j has at least one active loan in year t. Columns present alternative measures for credit access on the intensive margin: (1) Bank access dummy and interaction with interest payments to sales; (2) Bank access dummy and interaction with the interest rate; (3) Bank access dummy and interaction with total debt; and (4) Bank access dummy with variables for active loans above the median. Unit value measures the shipment value divided by the number of units in logs. Firm-level controls include sales, inventory-to-assets, leverage, cash to assets, sales growth and FDI receipt in the extensive, which are lagged by one year. Robust standard errors clustered at the firm-year level. $^{***}: pval < 0.001$, $^{**}: pval < 0.05$, $^{*}: pval < 0.1$.

term are statistically significant and their magnitudes and signs align with the findings in the main text. This pattern implies that for firms with better or cheaper access to credit (higher interest payments to sales, more debt, more loans, and lower interest rates), the marginal effect of longer sea shipping time on switching to air is attenuated, whereas firms facing higher interest rates are more sensitive to delays and more likely to substitute into air when sea is slow. In other words, even conditional on sea shipping time and rich fixed effects, intensive-margin credit conditions remain economically and statistically relevant for transport-mode choice.

Next, we test the robustness of our estimates on the relationship between credit access on the intensive margin and transportation mode by varying the fixed effects included in the specifications. Specifically, we consider multiple combinations of fixed effects including origin, destination, good and month separately, interacted origin-destination-good-month, year-sector, firm of origin, and even firm of destination effects, as documented in Tables **??** and **??** by checkmarks. The estimated equation is the same as Equation (3) from the main text, with the key difference being the set of fixed effects used across specifications. Controls remain identical to those in the main analysis. Across all these alternative setups, Tables 13 and 14 show that our key IV estimates remain stable, confirming the robustness of our main findings.

We next split the intensive margin measures into short- and long-term components to assess whether the effects of financial access differ over time. This distinction is important because it allows us to identify the time horizon that primarily affects the probability of shipping by air for each credit access measure. Results are displayed in Table 15. We observe consistent signs for the intensive margin coefficients both in the short- and long-term, but the effects are generally weaker or insignificant in the short term, reflecting how credit cost and access differ in their impact on transport mode choice at different horizons.

Table 12: Sea Shipping Time, Credit Access, and the Probability of Shipping by Air - IV

	(1)	(2)	(3)	(4)
Sea shipping time	0.002	0.012***	0.013***	0.034***
	(0.003)	(0.002)	(0.002)	(0.010)
Sea time × Int. payments to sales	-0.051***			
	(0.014)			
Sea time × Int. rate		0.017***		
		(0.006)		
Sea time × Total debt			-0.005***	
			(0.001)	
Sea time × More loans				-0.041***
				(0.015)
Unit value	0.020***	0.019***	0.021***	0.019***
	(0.002)	(0.002)	(0.002)	(0.002)
Origin-Dest-Good-Month FE	✓	✓	✓	✓
Year_Sector FE	✓	✓	✓	✓
Firm level Controls	✓	✓	✓	✓
N	4,514,433	4,267,522	4,521,862	4,524,022

Note: This table reports the IV estimates of the impact of sea shipping time and its interaction with measures of banking credit access on the likelihood of shipping by air. Interaction terms combine sea shipping time with alternative measures of credit access: interest payments to sales (standardized), interest rate (standardized), total debt (standardized), and a dummy for having a number of loans above the median. Unit value is the log shipment value divided by the number of units. Firm-level controls include sales, inventory-to-assets, leverage, cash to assets, sales growth, and FDI receipt in the extensive margin, all lagged one year. Robust standard errors are clustered at the firm-year level. $^{***}: p < 0.001$, $^{**}: p < 0.05$, $^{*}: p < 0.1$.

Table 13: IV results on interest payments and interest rates are robust to different specifications

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Int. payments to sales	0.204	-0.302***	-0.351***	-0.198***	-0.143**					
	(0.302)	(0.086)	(0.076)	(0.074)	(0.062)					
Int. rate						-0.023	0.087***	0.091***	0.033**	0.031**
						(0.080)	(0.024)	(0.024)	(0.014)	(0.015)
Unit value	0.010***	0.035***	0.019***	0.014***	0.012***	0.011***	0.034***	0.019***	0.013***	0.012***
	(0.004)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)
City Origin FE		✓					✓			
City Destination FE		✓					✓			
Good FE		✓					✓			
Month FE		✓					✓			
Origin-Dest-Good-Month			✓	✓	✓			✓	✓	✓
Year-Sector FE				✓	✓				✓	✓
Firm Origin FE				✓					✓	
Firm Destination FE					✓					✓
Firm level Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
N	4,863,186	4,861,440	4,595,841	4,558,741	4,518,554	4,602,272	4,600,578	4,346,753	4,310,053	4,272,009

Note: This table shows the robustness of IV results on interest payments to sales and interest rate to different specifications. Columns (1) and (6) have no fixed effects; columns (2) and (7) include origin, destination, good and month fixed effects individually; columns (3) and (8) have origin-destination-good-month fixed effects; columns (4) and (9) add firm of origin, in addition to origin-destination-good-month fixed effects; and columns (5) and (10) have origin-destination-good-month and firm of destination fixed effects. Unit value measures the shipment value divided by the number of units in logs. Firm-level controls include sales, inventory-to-assets, leverage, cash to assets, sales growth and FDI receipt in the extensive, which are lagged by one year. Robust standard errors clustered at the firm-year level. $^{***}: pval < 0.001$, $^{**}: pval < 0.05$, $^{*}: pval < 0.1$.

Finally, we demonstrate the credibility and robustness of our instrumental variables strategy by presenting the first stage, reduced form, and instrument balancing results. In the first stage of the IV approach, we assess the strength and relevance of our instrument—firms' differential exposure to the health of their lending banks—by estimating its effect on the endogenous credit access variables used in the main analysis. Intuitively, firms more exposed to healthier banks are expected to have improved credit access, as healthier banks are more able to lend and provide favorable credit terms. Therefore, we anticipate—and

Table 14: IV results on total debt and number of active loans are robust to different specifications

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Total debt	0.025	-0.044***	-0.047***	-0.017***	-0.015**					
	(0.043)	(0.012)	(0.009)	(0.006)	(0.006)					
More loans						0.152	-0.264***	-0.356***	-0.139**	-0.108**
						(0.263)	(0.094)	(0.125)	(0.064)	(0.054)
Unit value	0.011***	0.036***	0.020***	0.014***	0.012***	0.010**	0.035***	0.018***	0.013***	0.011***
	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.005)	(0.002)	(0.002)	(0.002)	(0.002)
City Origin FE		✓					✓			
City Destination FE		✓					✓			
Good FE		✓					✓			
Month FE		✓					✓			
Origin-Dest-Good-Month			✓	✓	✓			✓	✓	✓
Year-Sector FE				✓	✓				✓	✓
Firm Origin FE				✓					✓	
Firm Destination FE					✓					✓
Firm level Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
N	4,870,974	4,869,226	4,603,270	4,566,166	4,525,938	4,873,346	4,871,595	4,605,489	4,568,339	4,528,090

Note: This table shows the robustness of IV results on total debt and number of loans above the median to different specifications. Columns (1) and (6) have no fixed effects; columns (2) and (7) include origin, destination, good and month fixed effects individually; columns (3) and (8) have origin-destination-good-month fixed effects; columns (4) and (9) add firm of origin, in addition to origin-destination-good-month fixed effects; and columns (5) and (10) have origin-destination-good-month and firm of destination fixed effects. Unit value measures the shipment value divided by the number of units in logs. Firm-level controls include sales, inventory-to-assets, leverage, cash to assets, sales growth and FDI receipt in the extensive, which are lagged by one year. Robust standard errors clustered at the firm-year level. *** : $pval < 0.001$, ** : $pval < 0.05$, * : $pval < 0.1$.

Table 15: Main empirical results in the short and long term - IV

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Int. paym. to sales, short term	-0.218							
	(0.152)							
Int. paym. to sales, long term		-0.256**						
		(0.117)						
Int. rate, short term			0.058					
			(0.043)					
Int. rate, long term				0.055*				
				(0.033)				
Total debt, short term					-0.066*			
					(0.037)			
Total debt, long term						-0.019**		
						(0.008)		
More loans, short term							-1.279	
							(4.751)	
More loans, long term								-0.099**
								(0.046)
Unit value	0.012***	0.011***	0.012***	0.012***	0.012***	0.011***	0.006	0.011***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.021)	(0.002)
Origin-Dest-Good-Month FE	✓	✓	✓	✓	✓	✓	✓	✓
Year_Sector FE	✓	✓	✓	✓	✓	✓	✓	✓
Firm level Controls	✓	✓	✓	✓	✓	✓	✓	✓
N	3,476,281	4,393,203	3,473,647	3,837,380	3,482,406	4,394,967	4,527,838	4,527,838

Note: This table reports the IV estimated coefficients from regressions that include alternative measures of financial variables. Each specification includes Origin-Destination-Good-Month and Year-Sector fixed effects, as well as firm-level controls. Robust standard errors are clustered at the firm-year level. *** : $p < 0.001$, ** : $p < 0.05$, * : $p < 0.1$.

indeed find—positive first-stage coefficients for variables such as interest payments to sales, total debt and loans above the median, and negative coefficients for interest rates. Importantly, the F statistics reported in Table 16 are all well above conventional thresholds, which indicates a strong first stage.

The reduced form and instrument balancing provide additional validation for our IV strategy by examining the direct relationship between the instrument and the outcome, as

Table 16: First Stage Estimates

	(1) Int. payments to sales	(2) Int. Rate	(3) Total debt	(4) More loans
Z	0.025***	-0.115***	0.198***	0.028***
	(0.004)	(0.020)	(0.024)	(0.009)
Origin-Dest-Good-Month FE	✓	✓	✓	✓
Year_Sector FE	✓	✓	✓	✓
Firm level Controls	✓	✓	✓	✓
F statistic	30.66	31.71	66.38	10.17
N	4,559,233	4,310,538	4,566,662	4,568,834

Note: This table presents the first stage regression coefficients. Where Z is the firm's exposure to healthier banks as defined in equation 4). Total debt represents total outstanding bank loans; interest payments-to-sales measures annual interest payments to banks over sales; rate is the average yearly bank interest rate; "more loans" is a dummy equal to one for firms above the sample median number of bank loans. Robust standard errors are clustered at the firm-year level. *** $p < 0.001$; ** denotes $p < 0.05$; * denotes $p < 0.1$.

well as assessing the exogeneity of the instrument. Table 17 shows statistically meaningful reduced form effects across different sets of fixed effects. Importantly, these relationships align with the theoretical and empirical expectations, since we find a negative and significant associations between credit access proxies and the probability of shipping by air. Meanwhile, Table 18 indicates that the instrument is well balanced across key covariates, which supports the assumption of independence from the error term.

Table 17: IV Reduced Form

	(1)	(2)	(3)	(4)	(5)	(6)
Z	0.005	-0.009***	-0.009***	-0.007***	-0.004***	-0.003**
	(0.010)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)
Unit value	0.012***	0.036***	0.020***	0.021***	0.014***	0.012***
	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
City Origin FE		✓				
City Destination FE		✓				
Good FE		✓				
Month FE		✓				
Origin-Dest-Good-Month			✓	✓	✓	✓
Year-Sector FE				✓	✓	✓
Firm Origin FE					✓	
Firm Destination FE						✓
Firm level Controls	✓	✓	✓	✓	✓	✓
R^2	0.095	0.618	0.759	0.760	0.784	0.820
N	4,873,346	4,871,595	4,605,489	4,568,834	4,568,339	4,528,090

Note: This table presents reduced form regression coefficients, reporting the effect of the instrument (Z), defined as firm exposure to healthier banks (see equation 4), directly on the outcome variables of interest. Total debt is the firm's total bank loans; interest payments-to-sales measures annual interest payments to banks over sales; rate is the average yearly bank interest rate; "more loans" is a dummy equal to one if the firm has above-median number of bank loans. Each column represents a different specification, given by the selection of fixed effects. All regressions include the baseline set of firm controls. Robust standard errors are clustered at the firm-year level. *** $p < 0.001$; ** denotes $p < 0.05$; * denotes $p < 0.1$.

Table 18: Compliers Structure

	(1) X * Unit value	(2) X * Demeaned leverage	(3) X * Invent. to assets	(4) X * Initial sales	(5) X * Cash to assets	(6) X * Sales growth	(7) X * Dummy: Received FDI
Z	5.997	-0.003***	0.005***	0.251***	0.001***	0.072	0.003*
	(3.652)	(0.001)	(0.001)	(0.047)	(0.000)	(0.070)	(0.002)
Unit value		-0.000	-0.001***	-0.022	-0.000	-0.041	0.000
		(0.000)	(0.000)	(0.016)	(0.000)	(0.040)	(0.001)
Demeaned leverage	71.966**		-0.009	0.137	0.006**	0.172	-0.032*
	(32.933)		(0.011)	(0.345)	(0.003)	(0.395)	(0.018)
Invent. to assets	-80.295	-0.006		0.373	0.011***	0.235	-0.014
	(66.951)	(0.007)		(0.350)	(0.002)	(0.369)	(0.018)
Initial sales	-2.476	0.003***	0.003*		0.001***	-0.023	0.001
	(3.294)	(0.001)	(0.002)		(0.000)	(0.019)	(0.003)
Cash to assets	-146.080***	0.025*	-0.026*	-2.612***		-0.967	0.041*
	(56.295)	(0.014)	(0.013)	(0.576)		(0.848)	(0.022)
Sales growth	4.307	0.001	0.010	0.420	0.000		-0.002
	(3.293)	(0.003)	(0.009)	(0.364)	(0.000)		(0.001)
Dummy: Received FDI	10.584	-0.006**	-0.003	-0.063	0.002*	-0.203	
	(14.313)	(0.003)	(0.004)	(0.222)	(0.001)	(0.194)	
Origin-Dest-Good-Month FE	✓	✓	✓	✓	✓	✓	✓
Year_Sector FE	✓	✓	✓	✓	✓	✓	✓
Firm level Controls	✓	✓	✓	✓	✓	✓	✓
R^2	0.577	0.330	0.467	0.471	0.403	0.214	0.431
N	4,559,233	4,559,233	4,559,233	4,559,233	4,559,233	4,559,233	4,559,233

Note: This table reports the distribution of baseline firm characteristics in the effective population identified by our instrumental variable design (i.e., compliers), following Hull (2025). X represents interest payments to sales. All specifications include the same controls and fixed effects as in equation 3, and robust standard errors are clustered at the firm-year level. *** $p < 0.001$; ** denotes $p < 0.05$; * denotes $p < 0.1$.

Appendix D Model

D.1 Model calibration

Time-to-build The model implies that the total variable wage bill (excluding the fixed cost) in region o, sector j is given by:

$$w_o L_{oj}^v = \sum_d \sum_m \frac{\sigma - 1}{\sigma} \left(R_{oj}\right)^{-(\bar{\tau}_j + \tau_{odjm})} \pi_{odj} X_{odj}$$

and the total debt required to finance variable labor is given by:

$$D_{oj} = \frac{1}{R_{oj} - 1} \sum_d \sum_m \frac{\sigma - 1}{\sigma} X_{odj} s_{odjm} \left[1 - \left(R_{oj}\right)^{-\bar{\tau}_j - \tau_{odjm}}\right].$$

So that we can calibrate τ_j^0 to match the average sectoral debt-to-sales ratio in the data:

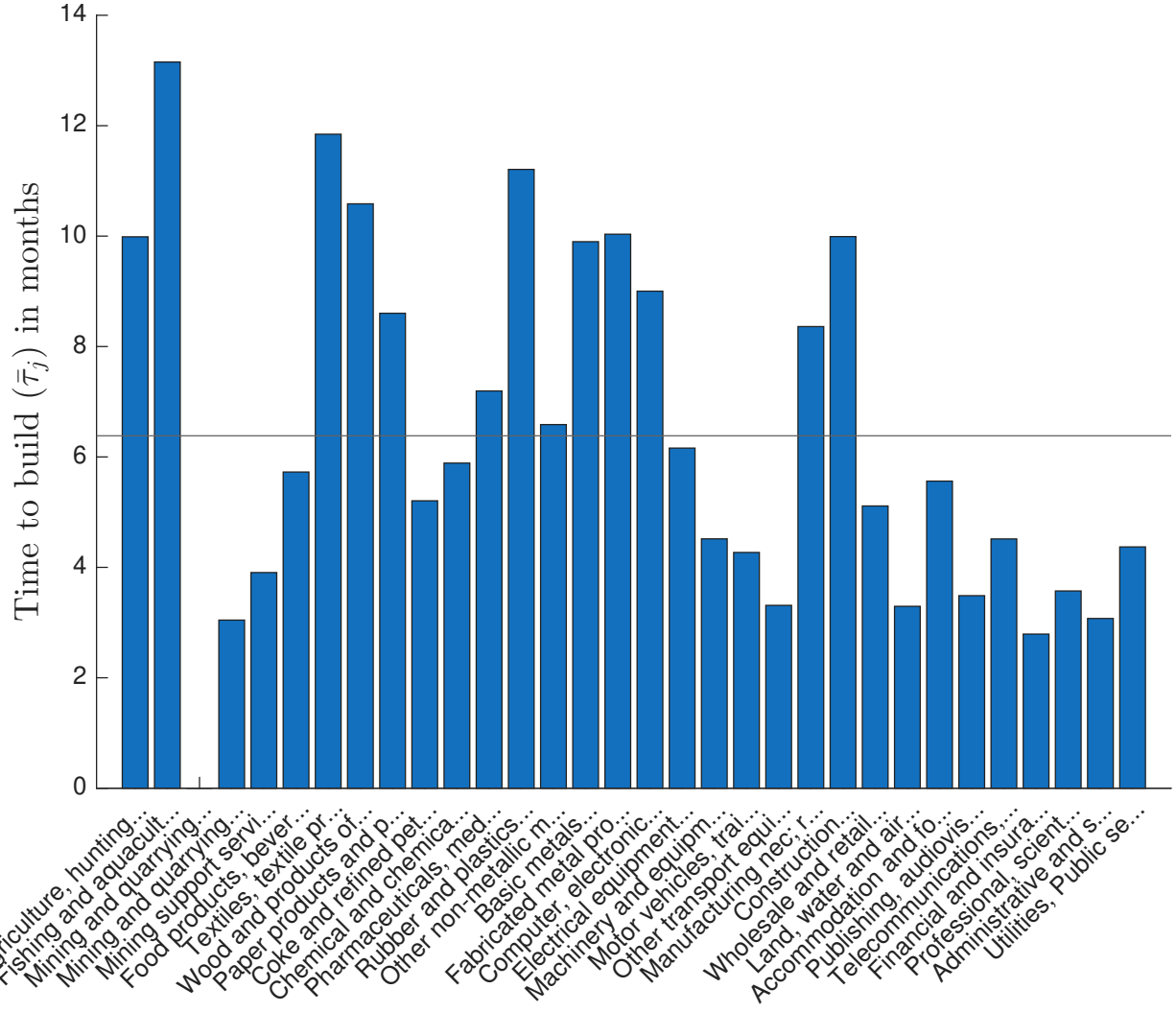
$$\frac{D_{oj}}{X_{oj}} = \frac{\frac{1}{R_{oj}-1} \sum_d \sum_m \frac{\sigma-1}{\sigma} X_{odj} s_{odjm} \left[1 - \left(R_{oj}\right)^{-\bar{\tau}_j - \tau_{odjm}}\right]}{\sum_d \sum_m X_{odj} s_{odjm}} \tag{D.1}$$

Given data on $\frac{D_{oj}}{X_{oj}}$, trade flows, mode shares, interest rates and τ_{odjm}, we use equation (D.1) to calibrate $\bar{\tau}_j$.

Figure 11 plots our sectoral estimate of $\bar{\tau}_j$ by sector. Figure XX shows how it also correlates to the Rajan and Zingales measure of external finance dependence.[23]

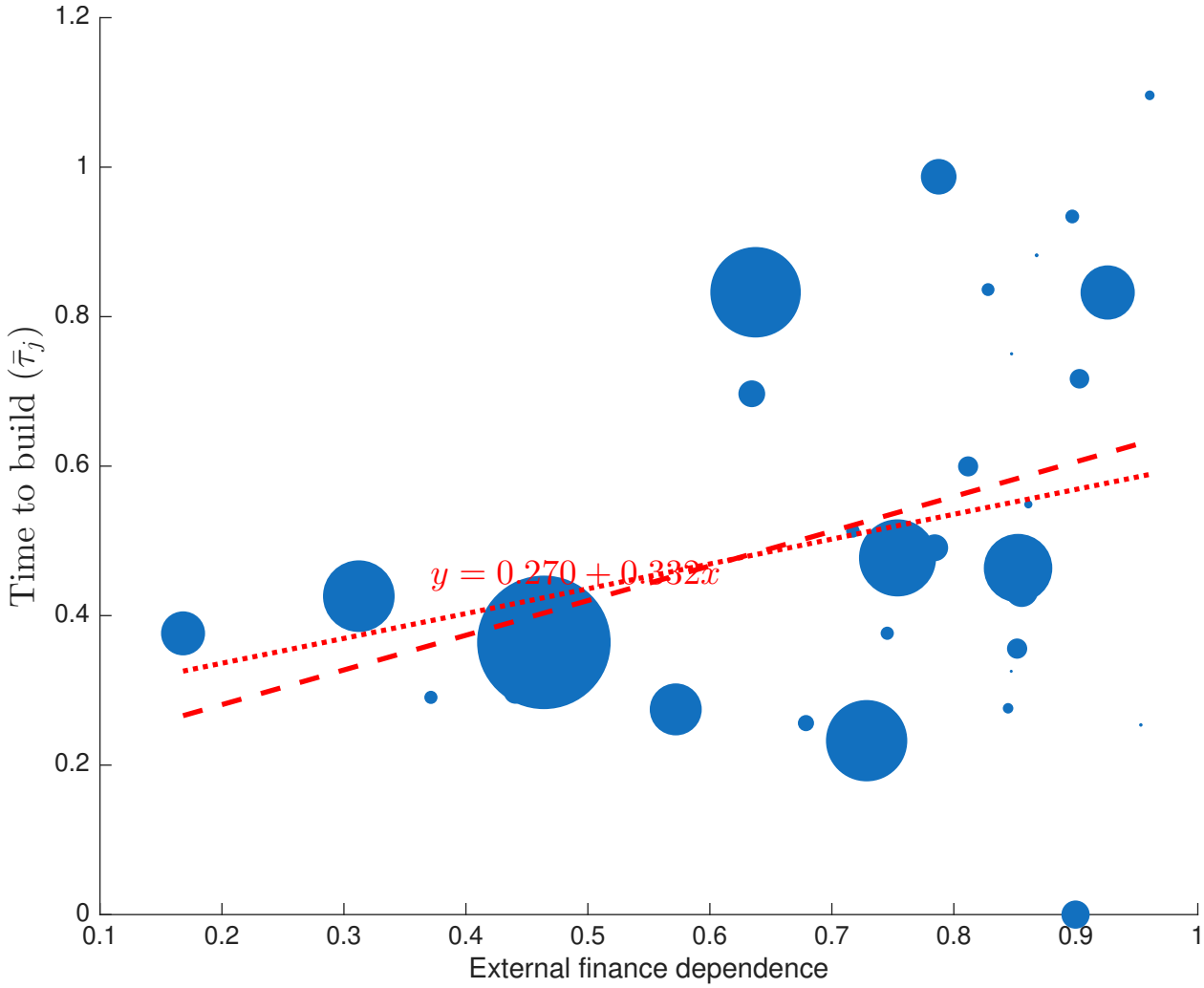
[23] That measure is computed as capital expenditures net of cash flow, divided by capital expenditures.

Figure 11: Calibrated time to-build ($\bar{\tau}_j$)



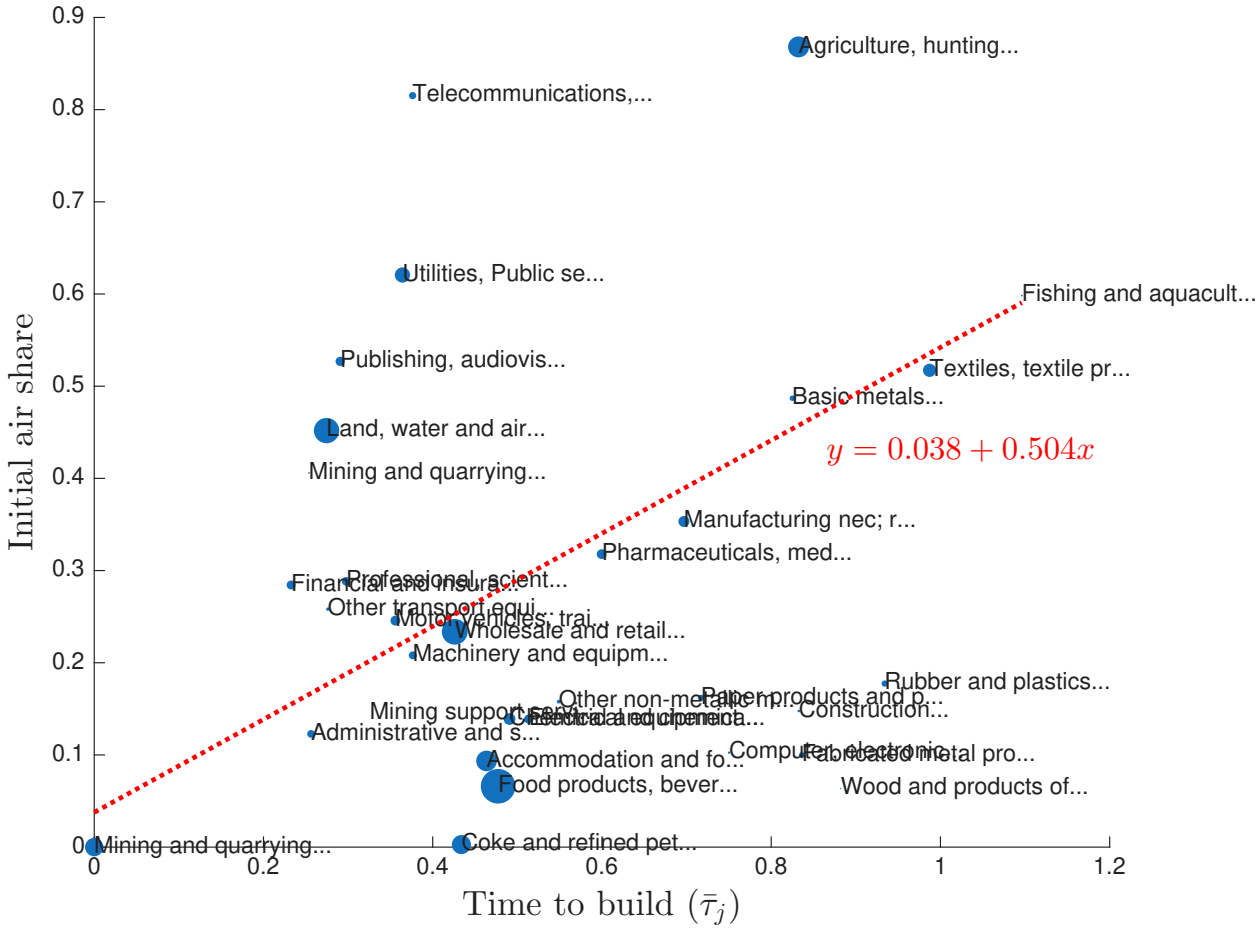
Notes: the figure plots the calibrated value of $\bar{\tau}_j$ obtained by matching the ratio of sectoral debt to sectoral sales in the data and the model.

Figure 12: Other correlates of time to-build ($\bar{\tau}_j$)



Notes: the figure plots the calibrated value of $\bar{\tau}_j$ against the measure of external finance dependence.

Figure 13: Time to-build ($\bar{\tau}_j$) and air intensity



Notes: the figure plots the calibrated value of $\bar{\tau}_j$ against sectoral air share in the data.