Do Financing Frictions Amplify Shocks to Exports?

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ABSTRACT

This paper shows how financing frictions can significantly amplify and prolong the effect of economic shocks to exports (e.g., shocks to export demand or tariff shocks). We propose a new financial multiplier effect leading to this effect, whereby changes in firms' exports affect their balance sheet conditions, which then shape firms' ability to finance new export transactions. Using customs data for Brazil, we first document a central prediction from this mechanism: shocks to economic conditions in certain export destinations lead to strong and persistent positive effects on the level of firms' exports to other existing destinations (positive within-firm spillover). We develop an identification strategy to refine this evidence, and both isolate and estimate the magnitude of the multiplier we propose. We then build a structural model of this mechanism, calibrate it using detailed data on the cost and financial structure of firms, and use it to simulate the effects we study. We find that the multiplier effect we propose can explain our empirical results both quantitatively and qualitatively. Using this calibrated model (and our empirical results), we quantify the role of funding frictions in amplifying and prolonging the effect of economic shocks to exports.

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We propose and test a new mechanism through which financing frictions can increase fluctuations in export activity. Exporters typically need to finance their production because of working capital requirements, i.e., they receive the cash from their export sales with some delay after their production costs are incurred. In the presence of funding constraints, the internal funds available for these firms will shape their ability to finance new export transactions.[1] At the same time, these internal funds are shaped by their recent export activity. This leads to a feedback loop and a financial multiplier effect that can amplify and prolong the effect of economic shocks to exports. For example, suppose a drop in demand significantly reduces the exports of a given firm. This drop reduces the profits and internal funds available for the firm to finance new transactions, further reducing its exports, internal funds, and export capacity. Moreover, this effect can be quantitatively important because of leverage (operating and financial). Firm sales translate into internal funds only after fixed costs (e.g., wages) have been paid. Therefore, a given change in sales due to exports (e.g., a five percent drop) can translate into a significantly larger change in internal funds (in percentage terms). We argue, both theoretically and empirically, that this mechanism can be economically significant and contribute to fluctuations in export activity.[2]

This analysis highlights the interaction between economic shocks to exporters and their funding constraints (balance sheet conditions). Our focus on this interaction is motivated by important empirical facts. First, exports are significantly more volatile than overall economic conditions (GDP). This volatility captures sharp fluctuations in exports, that typically last a few years and lead to export cycles with a frequency comparable to the one of traditional business cycles (but larger magnitudes). Figure 1 illustrates this pattern in the context of the U.S. and Brazil (our empirical setting). Importantly, this pattern holds across a broad range of countries and time periods and is not only present during specific episodes such as the great trade collapse (2008-2009). Second, the literature has found that this export volatility is largely driven by the greater exposure of trade to economic activities that are inherently more volatile. For example, trade is

[1] This point remains valid even if firms largely rely on external funds. For example, suppose that, for each dollar required to fund export transactions, firms raise \$0.6 in external funds and finance the remaining \$0.4 internally. Given internal funds equal to w, the firm can invest $w/(1-0.6)$. An increase of 5 percent in the available internal funds allows the firm to expand this short-term investment by 5 percent.

[2] Working capital requirements for exporters are consistent with the data and have been highlighted by previous research, which has also provided support for the presence of these funding constraints. For example, see Amiti and Weinstein (2011), Manova (2013), Feenstra, Li, and Yu (2014), Paravisini et al. (2015), Bruno and Shin (2023), and the references therein. Our analysis focuses on the implications of these constraints for fluctuations in exports.

largely concentrated in manufactured and durable goods, as opposed to other activities such as services. As the spending on these goods (investment and consumption of durable goods) is more exposed to economic cycles, exporters face significant fluctuations in their demand conditions.[3] As in our mechanism, short-term fluctuations in exports largely capture changes in their level among existing exporters in a market, as opposed to entry and exit decisions into export markets (see Section 4).

Our findings illustrate how financing frictions can significantly magnify this high volatility of trade originating from economic conditions. While previous research has examined how finance might shape fluctuations in exports, this research focuses on the role of financial shocks (i.e., shocks to the suppliers of credit such as banks) and typically considers financial and demand conditions as alternative factors shaping exporters' decisions. Indeed, many studies have estimated a quantitatively small role for financial frictions in explaining fluctuations in exports (e.g., during the great trade collapse in 2008-2009) by arguing that these fluctuations are mostly associated with changes in export demand. We find that this approach can significantly underestimate the role of financing frictions, because financing frictions and demand conditions interact in export markets and should not be seen as separate factors shaping export activity.

A few studies have considered this interaction between firms' funding constraints and economic shocks in export markets but have argued that these constraints limit firms' ability to respond to shocks and end up reducing the effect of shocks on exports. We incorporate this theoretical possibility in our analysis and show conditions that lead to an effect in the opposite direction (amplification of firms' responses to shocks).[4] Relatedly, our analysis shows how funding issues can increase the response of exports to economic shocks (or changes in policies such as tariffs) even in the absence of major changes in the supply of credit.

To study the importance of this financial multiplier effect, we build on customs data covering the universe of export transactions for Brazilian firms between 1996 and 2006, which allows us to

[3] Using data across several countries over multiple decades, Engel and Wang (2011) document that cycles in exports are typically two to three times more volatile than business cycles (cycles in GDP). They argue that this pattern cannot be explained by exchange rates. For example, this volatility of export cycles is also discussed by Alessandria, Kaboski, and Midrigan (2010) and Ahn, Amiti, and Weinstein (2011). On the determinants of this volatility and the role of export demand conditions, see Eaton et al. (2016) and the review by Bems, Johnson, and Yi (2013).

[4] For references on these points, see the literature review below (Section 1). These effects can also be present for firms only selling to domestic markets. However, they are especially relevant for exporters because of the higher economic volatility associated with trade, i.e. greater underlying economic volatility to be amplified.

track these transactions by firm, product, destination, and time (month). Guided by a model of this mechanism, we first document new empirical facts on exporters' responses to product-market conditions that capture key predictions from this effect. Using an identification strategy that refines these facts, we provide reduced-form evidence on the economic importance of this financial multiplier effect and estimate its magnitude. We then develop and calibrate a structural model of this mechanism. After calibrating our model with detailed information on the cost and financial structure of firms, we show that it can quantitatively and qualitatively replicate our empirical results. Using this calibrated model (and our empirical results), we quantify the role of financing frictions in amplifying and prolonging the effect of economic shocks on exports.

We start our analysis by documenting new empirical facts that capture key predictions from the mechanism we propose. When this mechanism is important, shocks to certain export destinations from a firm should lead to strong positive spillovers on its level of exports to other destinations. For example, suppose a firm exports to the U.S. and Germany. A shock reducing (increasing) the firm's exports to the U.S. should also reduce (increase) its exports to its existing markets in Germany. Intuitively, the change in sales and internal funds triggered by the U.S. shock should affect the firm's ability to fund new export transactions in all markets. This positive spillover effect (within the firm) captures shifts in the firm's balance sheet conditions. Moreover, these spillover effects should be persistent. In the previous example, a U.S. shock today can have significant effects on exports to Germany over multiple periods, due to the propagation effect of higher sales today on greater export capacity tomorrow.

In our mechanism, these spillover effects are driven by firm balance sheets and operate independently from any economic link across export markets, e.g., the firm might sell unrelated products in the U.S. and Germany in the example above. In theory, it is unclear how economic links would lead to these positive spillover effects in the time horizons we analyze (one to three years). Indeed, previous research suggests that, if present, such firm economic spillovers should be negative as firms face decreasing returns to scale or have incentives to reallocate scarce production factors across markets (e.g., labor).[5] When our mechanism is not important, funding

[5] For example, see the analyses of economic spillovers across different product markets within the firm in Almunia et al. (2021) and Ding (2025). In traditional models of firms and trade (along the lines of Melitz (2003)), firms have constant marginal costs, and these economic spillovers across export markets are not present.

frictions might also lead to negative spillovers as they limit firms' ability to expand across all markets at the same time (creating a competition for scarce funds).

To analyze the importance of these spillover effects, we consider an exporter faced with potential shocks (e.g. shifts in export demand) to its different markets (product ×destinations). The total effect of these shocks on a given market will be shaped by two factors: direct effects and firm-level spillovers. Direct effects capture how firms' exports in a market respond to shocks to that same market. Firm spillover effects capture the spillover effects discussed above. We analyze the effect of exchange rate shocks to product destinations (market-specific shocks) and show how to decompose the total effect of these shocks on exporters using these two components. We focus on exchange rates because they provide a large sample of shocks to demand conditions in specific destinations that have a clear timing, are difficult to predict (unrelated to other conditions), and can be compared across destinations and time.[6] We document that shocks to export destinations are associated with positive and economically strong firm-level spillovers, and estimate that these effects represent 40 percent of the total effect of shocks (over a three-year time horizon). We also confirm that these spillover effects are persistent over time and remain strong even as the direct effects of these shocks fade away over time.

We then refine this evidence to better isolate the importance of the financial multiplier effect we propose. To do so, we analyze firm spillover effects from temporary shocks to export destinations. We also analyze in greater detail the potential mechanisms driving these spillovers. Our focus on temporary shocks is motivated by identification considerations. The multiplier effect we study captures the propagation of a shock to exports in period t into firm export decisions in subsequent periods (from period t+1 on). To isolate how a shock in period t propagates into period $t + k$, one needs to disentangle this propagation effect from the direct effect of the same shock or from other correlated shocks in period $t + k$. One way to estimate such propagation effects is to isolate the effect of temporary shocks in period t, which do not have direct effects or are not correlated with shocks in period $t + k$. Going back to the example above, we now estimate if a

[6] To study shocks to demand conditions in specific destinations, we analyze changes in market-specific exchange rates conditional on time fixed effects. Firms have different exposures to these market-specific exchange rates because of the composition of their exports. Conditional on the same price for the exporter (in its domestic currency), there is an increased demand for the good in a foreign country when the country's currency appreciates (demand conditions are shaped by foreign currencies). This analysis controls for other potential effects of exchange rates such as their effect on dollar-denominated debt or domestic economic conditions and isolates this product-market effect.

temporary shock to the firm's U.S. exports in period *t* leads to significant positive spillovers on the firm's exports to Germany from period *t*+1 on, i.e., as soon as the internal funds from temporary shocks become available to fund new transactions.

We show how to construct these temporary shocks to demand conditions in specific export destinations using exchange rates.[7] To address a potential concern that firm spillover effects could be correlated with direct effects from the shocks, we analyze how differences in exports within the same product × destination × time are shaped by *temporary* shocks to *other* destinations from the same firm.[8] We estimate that temporary shocks to export destinations lead to economically strong and positive firm spillover effects. As predicted by our mechanism, these effects become significant right after the temporary shocks. Moreover, also consistent with this mechanism, we estimate these spillover effects to be highly persistent over time during a three-year time horizon.

To analyze the mechanisms driving these spillovers in greater detail, we start by providing additional evidence that these effects cannot be explained by economic links. We capture potential economic links across markets (product × destinations) using detailed information on the products being exported. The idea is that economic connections across firms' decisions in different export markets should be stronger when firms sell closer products in these markets. Intuitively, these connections could capture the use of common inputs (e.g., same workforce) and technology by firms when selling to different destinations. Consistent with the view that economic spillover effects are negative, we estimate that spillover effects are comparable but weaker when markets are economically closer (across a range of measures for this economic distance).

We then show that the spillover effects we document are related to the importance of balance-sheet effects. For example, we find that shocks only lead to these spillover effects when they have significant effects on firms' total exports and hence matter for firm balance sheets. We also show that the magnitude of these spillover effects is largely explained by the importance of operating

[7] For example, consider two export destinations, with currencies A and B, that both appreciated by 2 percent (relative to the domestic currency) during a semester. While A appreciated by 7 percent in the first three months and depreciated by 5 percent in the next three months, B had the opposite pattern (5 percent depreciation followed by 7 percent appreciation). Exporters exposed to currency A experience on average a greater foreign currency appreciation during the semester (stronger foreign demand conditions). However, this temporary difference should not forecast future gaps between the two currencies and demand conditions after the end of the semester.

[8] We can estimate these effects of temporary shocks because: (i) this analysis captures the effect of firm-specific exchange rates, (ii) firm spillover effects depend on all other markets from the firm, and (iii) there are approximately 43,000 firms in our sample with unique exchange rates.

leverage for firms, i.e., our results are stronger when firms have higher fixed operating costs (wages). This supports a central prediction from our mechanism: operating leverage is a key factor in explaining the extent to which changes in firm sales have levered effects on their internal funds and subsequent export capacity.[9] We discuss the challenges for alternative mechanisms to explain our findings and provide additional evidence addressing such concerns. Using this reduced-form evidence, we estimate the implied economic magnitude of the financial multiplier effect we propose. We estimate that this multiplier is economically large: an initial drop (increase) in firm exports of 10 percent leads to an additional drop (increase) of 4 to 6 percent over the subsequent year (through firm balance sheets).

As a final and important step in our analysis, we develop and calibrate a structural model of the financial multiplier effect we propose. We use this analysis to check if the mechanism we propose can quantitatively and qualitatively explain our empirical findings. Crucially, we do not use our empirical results to calibrate our model. Instead, we use moments from detailed data on the structure of firms' costs and their financing of production (working capital financing). We show how, in the context of our model, these costs and financial structure are key factors determining the economic significance of the mechanism we propose. Intuitively, our mechanism becomes economically significant when changes in firm sales have levered effects on internal funds (determined after fixed obligations), and the structure of costs and working capital financing shapes this effect.[10] After calibrating our model to match these key moments, we use it to simulate our empirical analysis. We find that the model predicts an economically strong and highly persistent financial multiplier effect that matches well the one we empirically estimate (including the magnitude above). This exercise also shows that this financial multiplier effect can quantitatively explain the empirical facts we document on the importance of firm spillover effects and their significant role in shaping firms' responses to shocks. This analysis shows that our reduced-form empirical results can be rationalized by the mechanism we propose.

[9] Our framework does not predict a clear link between our effects and the importance of financing constraints (or financial leverage). Reduced financing constraints allow firms to leverage more, and this leads to stronger effects as financial leverage works in a similar way to operating leverage. However, this greater access to finance can also predict a smaller probability that funding constraints are binding in the first place, a required condition for our mechanism to be relevant.

[10] Another important ingredient from our model is that shocks to internal funds also shape exporters' ability to finance their domestic production. This point is supported by our empirical findings and consistent with previous research and is needed for the effects from the financial multiplier to be highly persistent over time.

We conclude by using our calibrated model (and empirical results) to analyze how financing frictions shape firms' responses to the shocks we study (to export demand conditions). In the context of our model, we consider a counterfactual where firms do not face funding constraints in their ability to finance their working capital required for exporting. We find that funding frictions significantly increase the economic magnitude and persistence of the shocks, i.e., the effect of economic shocks on exports becomes 55 to 70 percent stronger in a three-year horizon. We note that this economic magnitude is close to the one we estimate using our empirical results on firm spillover effects. Our model illustrates how the impact of funding frictions on firms' responses to shocks can be inferred from empirical estimates of firm spillover effects. Overall, our main conclusion is that funding frictions significantly amplify and prolong the effect of economic shocks to exports.[11]

1. Related Literature

This paper relates to several strands of the literature. Our findings complement previous research debating the role of finance in shaping fluctuations in trade, an issue that has received significant attention since the great trade collapse during 2008-2009 (e.g., Amiti and Weinstein (2011), Chor and Manova (2012), Behrens et al. (2013), Paravisini et al. (2015), Bruno and Shin (2023), and Ma and Schmidt-Eisenlohr (2025)). As discussed above, the literature has focused on the role of financial shocks (shocks to the supply of credit) and typically considers financial frictions and export demand conditions as independent factors shaping changes in export activity. Indeed, many studies argue that funding frictions play a quantitatively limited role in shaping changes in exports based on the point that trade flows are changing in response to shifts in export demand, as opposed to financial shocks (e.g., see Bems, Johnson, and Yi (2013) for a review).[12]

Our analysis also relates to previous research studying how, in the presence of financing constraints, firms' balance sheet conditions help shape their decisions.[13] A few studies have considered how firm balance sheet conditions specifically interact with export decisions and have

[11] Consistent with our mechanism (see the discussion above), we also find that our results remain significant and stable across firms with different size, including larger firms. This addresses a concern that our results could have limited implications for aggregate exports.

[12] We discuss our contribution to this literature in the introduction. Another literature on finance and trade considers how finance can shape static patterns of trade and comparative advantages (see Foley and Manova (2015)).

[13] For example, see Almeida and Campello (2007), Hennessy and Whited (2007), Chaney, Sraer, and Thesmar (2012), Carvalho (2015), Giroud and Mueller (2019).

highlighted the role of funding frictions in limiting firms' responses to economic shocks (e.g., Kohn, Leibovici, and Szkup (2016, 2020)). Intuitively, when firms have less funds available to expand their production, this reduces their ability to increase their sales in response to new opportunities such as changes in export demand. We contribute to this literature by proposing and analyzing a new mechanism through which firm balance sheets magnify, as opposed to limit, the response of exports to economic shocks. This mechanism relates to a large literature on the role of financing frictions in amplifying and prolonging the effect of macroeconomic shocks, a financial accelerator effect, which highlights a feedback effect between firm balance sheets and *aggregate* economic conditions such as asset prices (e.g., Kiyotaki and Moore (1997), and Bernanke, Gertler, and Gilchrist (1999)). Our findings add to this literature by illustrating the importance of a financial multiplier that operates at the *firm level* and amplifies shocks to exports. This analysis highlights the interaction between working capital funding issues and operating leverage in explaining the quantitative importance of this firm-level multiplier.[14]

This focus on financing frictions that relate to firms' production links our paper to Almeida, Carvalho, and Kim (2024, hereafter ACK). We complement ACK by studying the role of these effects in shaping export activity, where frictions associated with the financing of production can be especially relevant, and by showing that these effects can amplify how firms respond to shocks to product market conditions. We also complement ACK by providing a quantification analysis of these implications and documenting the importance of operating leverage in driving these effects.

These findings also contribute to previous research analyzing how firm-level frictions can shape the response of exports to economic or policy shocks. This literature typically focuses on adjustments of trade over longer time horizons (e.g., ten to fifteen years) and highlights the role of entry and exit decisions into export markets, margins of adjustment that have been documented as important over such longer periods. An important theme in this literature is that entry costs can lead exporters to make decisions that become persistent over time and often respond only gradually to shocks. We complement these analyses by showing a different mechanism through which

[14] When many exporters are exposed to this effect, as suggested by our analysis, this firm-level multiplier can have important aggregate implications. See Brunnermeier, Eisenbach, and Sannikov (2012) for a review of this literature on the role of financing frictions in shaping macroeconomic shocks. Previous research has also argued that working capital funding issues (e.g., Jermann and Quadrini (2012)) and operating leverage (e.g., Favilukis, Lin, and Zhao (2020)) can have (other) important implications in the presence of financing frictions.

frictions can increase the response of exports to shocks over shorter time horizons (few years).[15] Our mechanism focuses on sharp changes in the level of exports among existing exporters and is motivated by the empirical importance of such fluctuations in export markets (see Section 4).

Additionally, this paper also relates to a few studies analyzing spillover effects between exporters' sales in foreign and domestic markets. Consistent with the predictions from the mechanism we study, Berman, Berthou, and Héricourt (2015, hereafter BBH) and Matray et al. (2025) estimate that shocks to exports lead to significant positive spillovers effects in domestic sales and argue that this effect is driven by funding frictions. BBH explicitly estimate the economic magnitude of this spillover and find that it is significant, in line with our findings on spillovers across export markets. On the other hand, Almunia et al. (2021) estimate negative spillover effects from shocks to domestic sales on exports in Spain during the Great Recession of the late 2000s and early 2010s. Our analysis is also consistent with their findings, as they study a period where exporters faced very adverse domestic demand conditions and might not be facing binding funding constraints in their ability to expand production (key condition required for our mechanism).[16] Relatedly, our findings are consistent with the evidence in Friedrich and Zator (2023) that the response of firms' exports and sales to shocks to export demand are stronger when firms have higher leverage (their analysis focuses on a one-year time horizon).

2. Theoretical Framework

We begin by discussing the theoretical framework that we use to motivate our empirical tests. We present the main intuitions here and show the formal model in Section 4. The starting point for our analysis is that exporters face a delay between the time they pay for production costs and the time they collect the cash from sales. This time gap is driven by multiple factors. The shipment and arrival of goods can take time, the payment for the goods happens with delay after their arrival and, in activities associated with trade (manufacturing), firms often rely on inventories and extend

[15] For example, see Baldwin and Krugman (1989), Roberts and Tybout (1997), Alessandria, Arkolakis, and Ruhl (2021), and the references therein. Relatedly, Xu (2022) provides evidence that temporary disruptions to the banking sector can have persistent effects on trade over decades by leading importers to build relationships with different exporters.

[16] This literature does not analyze the amplification of shocks to export markets and spillover effects across the different *existing* export destinations from a firm. A few studies analyze spillovers across firm entry decisions in different export markets and capture different economic mechanisms (e.g., Morales, Sheu, and Zahler (2019)). Our framework also illustrates that working capital funding constraints can lead to such negative spillover effects in settings where our mechanism is not sufficiently strong.

trade credit to their customers. This leads to working capital requirements, as the firm pays for costs upfront, making short-term investments that need to be financed.

We consider a firm that funds working capital requirements with a combination of internal funds and short-term credit. Intuitively, it is natural to expect firms to finance such short-term investments with short-term credit (e.g., Petersen and Rajan (1997)), which could come from different sources. Indeed, survey evidence confirms that exporters largely rely on internal funds (around 45 percent) as well as credit from banks, suppliers, or advances from customers (around 50 percent) when funding working capital needs in our empirical setting (see Section 4). We analyze a financially constrained firm that would like to expand its level of exports but cannot or finds it expensive to raise the required additional funding. Previous research across a range of empirical settings has supported the idea that these working capital constraints on the level of firm exports are important (see the references in the introduction).

We examine how this funding constraint shapes firms' responses to shocks to export demand conditions. The counterfactual is a scenario where the firm does not face frictions in its ability to fund its working capital, but all other conditions remain the same. On the one hand, these frictions limit firms' ability to respond to the demand shocks as firms need funds to scale up production when conditions improve, reducing the effect of demand shocks on firm exports. However, we illustrate how firm balance sheet conditions can also amplify and prolong the effect of these shocks on firm exports. In the presence of this funding constraint, the export activity of a firm will be shaped by the availability of internal funds. At the same time, internal funds are influenced by the firm's export decisions, leading to a feedback loop and a financial multiplier effect. For example, suppose the firm faces a significant drop in export demand. This drop reduces the profits and internal funds available for the firm to finance new transactions, further reducing its exports, internal funds, and export capacity.[17]

This multiplier effect can be quantitatively important when the firm's fixed obligations (both operating and financial) are significant relative to sales, due to a leverage effect. Firm sales

[17] To give a numerical example, suppose that, for each dollar required to fund export transactions, firms raise \$0.6 in external funds and finance the remaining \$0.4 internally. Given internal funds equal to w, the firm can invest $w/(1-0.6)$. An increase of 5 percent in the available internal funds allows the firm to expand this short-term investment by 5 percent.

translate into internal funds only after fixed costs (e.g., wages) have been paid. When these obligations are significant, a given change in sales due to exports (e.g., a five percent drop) can translate into a significantly larger change in internal funds (in percentage terms). Because of this leverage, shocks to exports in period t can lead to large persistent increases in firms' exports during subsequent periods (from period $t + 1$ on) through this financial multiplier. A last important condition we consider is that exporters also face funding frictions when financing their domestic sales (not only their exports). When this is the case, initial changes in internal funds can affect both exports and domestic sales, with stronger effects on firms' subsequent balance sheets, and this contributes to the magnitude and persistence of the previous multiplier effect. The idea that these funding constraints can also matter for the domestic sales of exporters is consistent with a range of evidence from different settings.[18]

We analyze a firm that exports to several markets, as in our data, where we define a market as a product × destination country. In this context, we illustrate a key prediction from this multiplier. When this mechanism is important, shocks to export destinations from a firm should lead to strong positive spillovers on its level of exports to other destinations. Specifically, suppose the firm is exposed to shocks to demand conditions in its different markets. The overall effect of these shocks on the firm captures the sum of two effects: direct effects and firm-level spillovers. Direct effects capture how firms' exports in a market respond to shocks to that same market. Firm spillover effects capture how an increase in demand at market A can change firm exports to a different market B. Our mechanism predicts the existence of significant positive spillover effects as an initial shock to some markets in period t shapes the firm's internal funds and ability to fund new export transactions in *all markets* (independently of any economic link across the markets). Hence, this initial shock leads to large persistent increases in the firm's exports across all markets in subsequent periods (from period $t + 1$ on).

In our framework, this positive spillover effect is not present when the previous financial multiplier is not important and captures the amplification of shocks to export demand. To see these

[18] For example, see Almeida, Carvalho, and Kim (2024) and Drechsler, Savov, and Schnabl (2024) for evidence and a discussion of why frictions associated with the financing of production factors (working capital needs) can limit firms' domestic sales. Behrens, Corcos, and Mion (2013), Berman, Berthou, and Héricourt (2015), and Matray et al. (2025) provide evidence that adverse shocks to exporters' financial conditions lead to reductions in their domestic sales. This condition does not imply that firms in activities not associated with trade (e.g., services) are also exposed to these same funding frictions when selling domestically.

points, note that an individual market typically represents a limited share of total exports, as in our data. Thus, shocks to one market do not significantly shape firm balance sheet conditions. Direct effects should capture firms' unconstrained responses to shocks, i.e., their responses in the absence of balance sheet constraints on production decisions.[19] The contribution of firm balance sheets and funding issues to firm responses to shocks is captured by spillover effects. When funding frictions limit firms' ability to respond to shocks, as opposed to amplify these responses, these firm spillover effects are negative. As balance sheet constraints limit the funds available for the firm to respond to shocks, this leads to competition across markets for internal scarce funds. Higher (lower) demand in one market creates incentives for the firm to reallocate funds towards (away from) that market.

In this analysis, we abstract away from potential economic spillovers across export markets. These economic spillovers are also not present in traditional models of firms and trade (along the lines of Melitz (2003)), where firms have constant marginal costs. In principle, these spillovers could be present, but previous research suggests that they would be negative under the time horizons we analyze (up to three years). These negative spillovers could be driven by decreasing returns to scale, as reductions (increases) in production in some markets reduce (increase) the marginal cost of producing for other markets (Almunia et al. (2021)). Alternatively, these negative spillover effects could capture an internal competition for production factors (e.g., labor), not internal funds, as firms find it costly to expand the total amount of the factor used in production (Ding (2025)).

2. Data, Sample, and Variables

2.1. Data and Sample Construction

The primary data source used in the paper is the administrative record of every legally recorded export transaction by Brazilian firms. This transaction-level customs data (*SECEX*) covers the period between 1996 and 2006. This data includes the following information for each export transaction: the value of the transaction, the exporter (unique firm identifier), the month of the transaction, the country of destination, and a product code for the product being exported. The

[19] Intuitively, when each market is small, a firm can significantly expand production in a single market by making small cuts to its production in other markets. As explained above, we define unconstrained responses as the ones in the absence of these working capital constraints.

product code includes the 6-digit code from the global Harmonized System (HS). In some analyses, we combine this export data with information on firms and their workforce, which comes from the labor force record RAIS (*Relação Anual de Informações Sociais*) from the Brazilian labor ministry. For example, this data allows us to measure the total number of workers for each firm over time and the firm's age. We also rely on exchange rate data to construct firm-specific exchange rates. Daily exchange rates for different currencies relative to the U.S. dollar are obtained from Datastream and linked to daily exchange rates for the Brazilian real relative to the U.S. dollar from the Brazilian central bank. Additionally, we use moments from detailed firm surveys on the financial and cost structure of firms to calibrate our model (see Section 4).

The main sample used in our analysis tracks firms' exports at the firm × product × destination × semester level. Our choice of semesters as the period is motivated by the mechanism we propose. Recall that, in this mechanism, shocks to one export destination in period t only have significant positive spillovers in other destinations at period t+1. This gap captures the time that it takes for exporters to collect the cash from initial transactions (with updated prices after the shock) and to complete a new production cycle with updated financial resources (recording new transactions). Previous research and anecdotal evidence suggest that it should take at least one quarter-semester for the positive effects above to become important (and not much longer).[20] Also motivated by our mechanism, we abstract away from entry decisions and focus only on markets (product × destinations) where firms already operate. We start our sample construction by including all observations where there is some export transaction for the firm × product × destination in the previous semester. We then restrict this sample to all cases where we can find exchange rate data for the export destination as we study firm-specific exchange rate shocks in our analysis (see below). Finally, since we track firms' export responses until semester t + 2 in our baseline results and rely on data from semester t -1, this sample covers the period between the second semester of 1996 and the second semester of 2005. This sample includes 2,492,806 observations covering 42,465 firms that export 5,155 products (6-digit HS codes) to 57 destinations. We replicate our main findings excluding the period around the 1998 Russian crisis (see the Internet Appendix).

[20] Previous research and anecdotal evidence suggest that it should take at least one quarter-semester for the positive effects above to become important (and not much longer). For example, this gap includes the time that it takes to deliver the goods and the fact that importers are typically not obliged to pay until 90 days after the goods arrival (e.g., Djankov et al. (2010), Amiti and Weinstein (2011)).

2.2. Export Growth Variables

The primary outcome variables in our analysis measure firms' export growth at the product × destination level, that we label as a market. We measure this growth between semesters t - 1 and $t + k$, where $k \geq 0$. Recall that we abstract away from entry effects and only include observations where the firm has some export activity in the market during semester t -1. We focus on growth measures that incorporate both intensive-margin changes to the level of exports in a market and exit decisions from that market. This is important as we want growth measures that capture the potential effects of firms' balance sheets on these two margins, which could both be economically relevant. Additionally, estimating the effects of shocks only in the intensive margin is challenging because of selection issues. The subset of firms that decides to continue operating in a market at semester $t + k$ is endogenously determined and shaped by the shocks we study. In contrast, our approach ensures that we are tracking all firms initially exposed to the shocks over time.

Our main measure of export growth is $ProdExpGrowth\,(t+k)$, the difference in firm × product × destination exports between semesters $t + k$ and t - 1, scaled by the average value of these exports across the two periods. The main advantage of this measure is that it is symmetric for expansions and contractions, and it leads to a bounded growth measure (this growth rate is always between -2 and 2), limiting the influence of growth outliers. For these reasons, this measure has been proposed and used by previous research when combining both intensive- and extensive-margin effects into growth rates (e.g., Davis and Haltiwanger (1992), Alfaro, Bloom, and Lin (2024)). We construct a measure of export growth at the firm level in the same way. $FExpGrowth\,(t)$ is the difference in firm total exports between semesters t and t - 1, scaled by the average value of these exports across the two periods. In the Internet Appendix, we show that our results remain similar when we use a simple growth rate measure: the difference in exports (firm × product × destination or firm exports) between semesters $t + k$ and t - 1, scaled by the value of these exports in the initial semester (t - 1). In this simple growth measure, growth rates are bounded by -1 on the left tail but unbounded on the right tail. While we measure firm products and construct these variables using 6-digit HS codes, in the Internet Appendix, we also show that our results remain similar when we define products as 4-digit HS codes.

2.3. Shocks to Firms' Export Demand Conditions

To construct shocks to the export demand conditions faced by individual exporters, we rely on firm-specific exchange rates. This analysis considers changes in market-specific exchange rates faced by firms, conditional on time fixed effects. Intuitively, firms have different exposures to market-specific exchange rates because of the composition of their exports. Conditional on the same price for the exporter (in its domestic currency or in dollars), an appreciation of a destination's currency increases demand for the good from that country. Demand conditions are thus shaped by foreign currencies because they determine the prices faced by foreign customers in their own currency. For example, consider two firms (A and B) that initially export to Germany and Japan, respectively. If the German currency appreciates relative to the Japanese, there is an improvement in the export demand conditions faced by firm A relative to firm B. This measure allows us to control for other potential effects of exchange rates, such as their effect on dollar-denominated debt or domestic economic conditions. This point remains valid even if exports are invoiced in a dominant currency such as the dollar (Gopinath et al. (2020)). In our example above, the appreciation of the German currency relative to the Japanese shifts demand even if export prices were determined in dollars (because exports become cheaper for German buyers).[21]

This approach to construct shocks to demand conditions using exchange rates has multiple advantages. It provides one with a large sample of shocks to demand conditions in specific destinations that have a precise timing, are difficult to predict (unrelated to other conditions), and can be compared across destinations and time. Indeed, previous research has suggested that is very challenging to predict future changes to exchange rates using past information across a broad range of evidence (e.g., see Rossi (2013) and the references therein). The broad sample of shocks comes from the fact that we construct shocks to firm-specific exchange rates and there are approximately 43,000 firms in our sample. A simple analysis of changes in economic conditions at product destinations would not identify such precise and largely unexpected shocks to export demand. We also use this approach to isolate temporary shocks to export demand conditions (see Section 3.2).

We construct shocks to firm-specific exchange rates that capture the overall shock faced by exporters across their existing export markets. For each exporter and semester, we calculate the

[21] The key assumption that we need in our analysis is that these shifts in the demand for products from specific countries can influence the price of the good in the producer's currency. Therefore, export prices can be sticky in a dominant currency or the producer's currency, but they must respond (at least partially) to changes in demand. Both our evidence and previous research directly support this assumption (see Section 4).

firm's initial share of exports from each destination using values from semester t - 1. Using these shares as weights, we then measure the weighted log changes to exchange rates (between semesters t – 1 and t) across the firm's initial destinations and label this shock as $FERShock\ (t)$. As we analyze exports to specific markets (product × destinations), we also define $Market\ ERShock\ (t)$ as the log change to the exchange rate in the market being analyzed, and $Other\ ERShock\ (t)$ as the average exchange rate shock across all other markets, excluding the market being analyzed and using market shares for this subset of other markets. To analyze temporary shocks to export demand conditions (see Section 3.2), we also construct $FERShock\ (t+1)$, which is defined in the same way as $FERShock\ (t)$ using changes in exchange rates between semesters t – 1 and t +1. Additionally, we construct shocks to firm-specific exchange rates that only incorporate shocks to products that are close or distant to the product being analyzed (see Section 3.4).

When analyzing the effects of these shocks, we do not control for the importance of hedging or sort firms based on this importance. We thus estimate amplification and propagation effects net of the impact of hedging on firm responses. In principle, firms could hedge their exposure to these shocks using financial instruments (e.g., financial derivatives) or operating strategies (e.g., matching exports with imports). While hedging could weaken the economic importance from our mechanism, previous research provides evidence that and discusses why firms hedge their exposure to risks only to a limited degree (e.g., see Almeida, Carvalho, and Kim (2024)).

2.4. Main Sample and Summary Statistics

Table 1 provides summary statistics. Panel A shows statistics for the main sample used in our analysis. Panel B shows basic firm characteristics available in our data. The unit of observation here is a firm × semester and we include all firm observations in the main sample from Panel A. On average, exporters in our sample have 298 employees, operate 2.85 plants, and export 5.50 products (six-digit HS code) to 4.36 destinations. Panel C shows that most of our sample, including the number of observations and aggregate export activity, covers manufacturing firms. While this share of manufacturing in Brazilian exports reduced after 2006 (end of our sample period), this importance of manufacturing in our sample mirrors the one in global trade (Eaton et al. (2016)).

3. Empirical Analysis

3.1. Firms' Responses to Export Demand Conditions: Direct and Firm Spillover Effects

We analyze the importance of firm spillover effects in shaping firms' responses to shocks export demand conditions. As outlined in Section 2.3, we capture shocks to firms' export demand conditions using firm-specific exchange rates ($FERShock\ (t)$). The total effect of these shocks on firms' exports to a given market (product ×destination) should be shaped by two factors: direct effects and firm-level spillovers. Direct effects capture how firms' exports in a market respond to shocks to that same market. Firm spillover effects capture the indirect effects (within a firm) from shocks to other export markets. Our mechanism predicts the presence of significant positive firm spillover effects (see Section 2). We examine this prediction by analyzing the importance of the two previous effects.

To implement this idea, we estimate the following specification:

$$ProdExpGrowth_{ipdt+k} = \alpha_t + \beta_1 \times Market\ ERShock_{idpt} + \beta_2 \times Other\ ERShock_{idpt} + \varepsilon_{ipdt}, \quad (1)$$

where $ProdExpGrowth_{ipdt+k}$ is the export growth of product p by firm i to destination d between semesters t - 1 and $t + k$, α_t is a time fixed effect, $Market\ ERShock\ (t)$ is the exchange rate shock to the market $p \times d$ (based on the destination), and $Other\ ERShock\ (t)$ is the exchange rate shock to the other markets from the same firm (see Sections 2.2 and 2.3 for variable definitions). The coefficients of interest are β_1 and β_2 and capture the direct and firm spillover effect discussed above. Note that, when estimating firm spillover effects in a market, we are only using shocks to exchange rates in other markets that are orthogonal to the exchange rate from the market being analyzed. This addresses a concern that the spillover effects might capture a correlation between shocks to the different markets in which a firm operates.[22]

Table 2 reports the results. We separately estimate the effects for three separate years since the start of the shock (in semester t). In each year, we average the outcome variable $ProdExpGrowth$ across the two semesters in each year. Figure 2 plots the results separately for each semester. We also show the total effect of firm-specific exchange rates: we estimate a specification equivalent to Equation (1), where we predict $ProdExpGrowth$ using α_t and $FERShock\ (t)$.

[22] This point comes from the fact that the estimation of β_2 is equivalent to an estimation in two stages (e.g., see Goldberger (1991)). In the first stage, we estimate a linear regression of $Other\ ERShock\ (t)$ on $Market\ ERShock\ (t)$ and α_t. This gives us a residual for $Other\ ERShock\ (t)$. In the second stage, we determine β_2 by regressing $ProdExpGrowth$ only on this residual shock to other markets (from the first stage). We further address this concern below.

The results show that there is an economically and statistically significant spillover effect. The economic magnitude of the estimated spillover effects is important relative to the one from the direct or total effects of shocks. To see this point, suppose that that there is a one percent (log point) increase (or decrease) in the exchange rate of all markets from a firm. This leads to a one percent increase (decrease) in $Market\ ERShock\ (t)$, $Other\ ERShock\ (t)$, and $FERShock\ (t)$. Using an average effect across the three years we analyze (average coefficients), we can then compare the relative importance of the spillover effect with the one from the direct and total effect. The spillover effect represents approximately 68 and 39 percent of the direct and total effect, respectively.

Importantly, as predicted by our mechanism (see Section 2), this positive firm spillover effect has a strong persistence over time (across a few years). While the direct effect of the shock fades away after the first year, the spillover effect becomes stronger and then stable over time (see Figure 2). The magnitude of the spillover effect matches the one from the direct effect in the second year and becomes significantly stronger after that. Another important point is that, in each year, the sum of the two effects (β_1 and β_2) is approximately the same as the total effect (from $FERShock\ (t)$). A one percent change in both $Market\ ERShock\ (t)$ and $Other\ ERShock\ (t)$ leads to a one percent change in $FERShock\ (t)$. Therefore, the sum of these two effects should be approximately the effect of $FERShock\ (t)$.[23] This estimation provides us with a simple decomposition of firms' responses to demand conditions and allows us to estimate the contribution of spillover effect to firms' overall response. We can estimate the contribution of spillover effects by using the ratio of the spillover effect and the total effect (average of each effect across the three years). Our estimates imply that firm spillover effects capture 39 percent of firms' overall responses to demand conditions over this three-year time horizon.

This positive and persistent firm spillover effect is robust across a range of checks. In the Internet Appendix, we show that this result remains similar with different measures of export growth and alternative product definitions. This finding also remains similar when we include product × destination × time fixed effects when estimating spillover effects. As we compare decisions by different firms within a same market and time, controlling for these fixed effects

[23] We capture marginal shocks as we analyze a broad sample of frequent fluctuations in exchange rates. This result then holds for marginal shocks because of a first-order approximation.

ensures that we are not capturing omitted direct effects. However, when we add such fixed effects, we are unable to estimate the joint importance of direct and spillover effects, as the fixed effects subsume the direct effects.

3.2. Temporary Shocks to Export Demand Conditions

We refine our evidence on positive and persistent firm spillover effects to better isolate the importance of the financial multiplier we propose. Motivated by identification issues, we first refine our analysis by focusing on spillover effects from temporary shocks to export demand conditions. The multiplier effect we study captures the propagation of an initial shock to exports in period t into firm export decisions in a subsequent period $t + k$ (where $k \geq 1$), i.e., when the internal funds from the initial shock become available to fund new transactions. In the data, a shock in period t can have direct effects or be correlated with other shocks in period $t + k$. To isolate how a shock in period t propagates into period $t + k$, one must disentangle this propagation effect from other potential effects associated with the shock. One way to estimate such propagation effects is to analyze the effect of temporary shocks in period t, which do not have direct effects or are not correlated with shocks in period $t + k$. Building on this idea, we examine if temporary shocks to export markets in period t lead to significant positive spillovers on the firm's exports to other markets from period t+1 on.

Our analysis relies on exchange rates to construct temporary shocks to firms' export demand conditions. This approach is motivated by the lack of predictability of future changes to exchange rates using past information (e.g., see Rossi (2013) and the references therein). To illustrate the basic idea from our approach, consider the following example. Suppose there are two export destinations with foreign currencies A and B, that both appreciated by 2 percent during a semester (relative to the domestic currency). While A appreciated by 7% in the first three months and depreciated by 5% in the next three months, B had the opposite pattern (5% depreciation followed by 7% appreciation). Exporters exposed to currency A experience on average a greater foreign currency appreciation during the semester (stronger foreign demand conditions). However, this temporary difference should not forecast future gaps between the two currencies and demand conditions after the end of the semester. What matters for forecasting future values of the exchange rates is their latest value at the end of the semester and both currencies experienced the same total appreciation at that point.

When implementing this analysis, we consider how differences across firm exports within a same product and destination (same market) are shaped by temporary shocks to *other* export destinations from these firms. We focus on differences across firms within a same export market to ensure that we are not capturing potential direct effects of the shocks we study. These direct effects are the same for all firms selling in a same market and period. Specifically, we construct temporary shocks to firm-specific exchange rates $FERShock\ (t)$ and then estimate the effects of these shocks after including product × destination × semester fixed effects. After the inclusion of these fixed effects, differences in $FERShock\ (t)$ must be driven by gaps in the shocks faced by firms in *other markets*. In principle, one could also implement this approach using a variable that captures shocks to other markets from the same firm, but there is an important advantage from using $FERShock\ (t)$. In our mechanism, the magnitude of spillover effects should be related to the importance of the overall shock to firms' balance sheets, and this is captured by $FERShock\ (t)$. Therefore, our approach allows us to isolate the effect of shocks to other markets while measuring their importance for the firm. When we refine our evidence to consider the role of economic links, we analyze specifications with variables that only include shocks to other markets.

To construct temporary shocks to firm-specific exchange rates during semester t, we rely on differences in $FERShock\ (t)$ after controlling for $FERShock\ (t+1)$, the shock to firm-specific exchange rates between $t-1$ and $t+1$. $FERShock\ (t+1)$ is measured in an analogous way to $FERShock\ (t)$ using log changes in exchange rates for each destination country between semesters $t-1$ and $t+1$ and weights from semester $t-1$. This approach formalizes the idea described above. Conditional on the cumulative change in exchange rates between period t - 1 and $t+1$ ($FERShock\ (t+1)$), gaps in $FERShock\ (t)$ across firms capture temporary changes in the exchange rates during semester t. As we implement our analysis, we consider two specifications: one only using a linear control for $FERShock\ (t+1)$ (Model 1) and one using a third-degree polynomial function of $FERShock\ (t+1)$ to construct the control variables (Model 2). We show results with non-linear controls to address potential measurement error issues.

We implement this approach by estimating the following specification:

$$ProdExpGrowth_{ipdt+k} = \alpha_{pdt} + \beta \times FERShock_{it} + \gamma_0 \times FERShock_{it+1} + \gamma_1{}' X_{ipdt} + \varepsilon_{ipdt}, \quad (2)$$

where $ProdExpGrowth_{ipd}(t+k)$ is the export growth of product p by firm i to destination d between semesters t - 1 and $t + k$, α_{pdt} is a product × destination × semester fixed effect, $FERShock\ (t+k)$ is the firm-specific exchange rate shock between semesters t - 1 and $t + k$, and X_{ipdt} is a vector with control variables. Importantly, as we estimate equation (2), we weight the observations using the initial shares of exports from the firm in each product × destination (measured in semester t - 1). Note that we analyze firm-level shocks, and this allows us to capture firm-level responses to these shocks.

As an initial step, we analyze how these temporary shocks to firm-specific exchange rates during semester t affect firms' total exports during that same semester. Table 3 shows the results, where we estimate equation (2) using $FExpGrowth\ (t)$ as the outcome variable. The results show that temporary shocks to firm exchanges during a semester have immediate effects on firms' total exports during that semester that are both economically and statistically significant. For example, column (1) implies that firms' total exports expand by 6.5 pp (= 0.14 × 0.465) during semester t in response to a one-standard-deviation increase in $FERShock(t)$ (0.14 from Table 1). This finding is robust across specifications and confirms that the temporary shocks we construct significantly affect export demand conditions. These results capture the effect of shocks to other export destinations on firms' total exports.

As discussed above, these temporary shocks to firm-specific exchange rates should not forecast future shocks to firm export demand conditions. Our approach also builds on the point that these shocks should be unrelated to previous firm characteristics. Importantly, the construction of temporary shocks to exchange rates should not create any potential link between firm characteristics and these shocks.[24] Indeed, Panel B of Table 3 uses firm-level data to show that these temporary shocks to firm-specific exchange rates are not related to differences in multiple firm characteristics that we observe: total employment, high skilled employment share, number of plants, number of export destinations, and the number of export products.

3.3. Firm Spillover Effects from Temporary Shocks to Export Markets

[24] This argument follows from the notion that these shocks are largely unpredictable. Note that we use continuous shocks to exchange rates which are not related to their volatility (as opposed to discrete shocks capturing tail events).

We estimate the spillover effects from temporary shocks to export demand conditions using the approach outlined above. Table 4 shows the results. We focus here on immediate spillover effects, between semesters *t* and *t*+2, from shocks that take place in semester *t*. In Section 3.6, we then examine the persistence of these effects. The key prediction from our mechanism is that positive spillover effects should become significant right *after* temporary shocks (from semester *t* + 1 on), i.e., as soon as the change in internal funds associated with the shock affects export transactions. In theory, spillover effects should be limited and can be negative during semester *t*. Intuitively, when there is an increased demand for exports in a certain market, a constrained firm will have incentives to reallocate resources towards that market. If firms can quickly reallocate their production during the short-lived shock, that lasts one semester, this can lead to negative spillover effects during semester *t*. Note that these incentives for reallocation end after semester *t*, when the temporary shock is over, and we should only observe positive spillover effects.

The results support these predictions from our mechanism. We first estimate that the spillover effects in semester *t* are negative and have limited importance (columns (1) and (2)). We then find positive spillover effects during semesters $t + 1$ and $t + 2$ (columns (3) to (6)). These positive spillovers are economically and statistically significant. For example, column (5) implies that firms expand their exports in a market by 3.7 pp (= 0.14 × 0.261) during semester $t + 2$ in response to a one-standard-deviation increase in $FERShock(t)$ (0.14 from Table 1) in other destinations. In the Internet Appendix, we show that these findings are robust across a range of specifications (e.g., different definitions of products and alternative measures of export growth). Overall, these results show that temporary shocks to firms' exports in a set of destinations have strong positive spillover on their subsequent level of exports to other locations.

3.4. Firm Spillover Effects: The Role of Economic Links

We analyze the mechanisms driving these spillovers effects in greater detail. As a first step, we provide additional evidence that these effects cannot be explained by economic links. Previous research suggests that, if present, economic spillover effects within the firm should be negative over the time horizons we analyze (up to three years).[25] To provide evidence that this is the case

[25] As documented by Ding (2025), while there can be positive spillovers within the firm, these effects should only be relevant over longer time horizons (five years or longer). For example, these effects can emerge from knowledge spillovers across markets that take time to emerge.

in our analysis, we estimate spillover effects across markets (product × destinations) with stronger versus weaker economic links. If economic spillover effects are negative, our previous results on positive spillovers should become *weaker* when economic links are *stronge*r. In the presence of both our mechanism and negative economic spillovers, the net spillover effects we estimate become less positive when economic spillovers are stronger. Using detailed information on the products being exported, we define economic links across two markets as stronger when these markets have products with greater similarity. The idea is that economic connections across firms' decisions in different export markets should be stronger when firms sell closer products in these markets. For example, these connections could capture the use of common inputs (e.g., same workforce) and technology by firms when selling to different destinations. In our data, products are defined using six-digit product codes from the global Harmonized System (HS), a detailed classification system that covers more than 5,000 products and is used to classify most international trade. Using these codes, we construct three measures of product distance or similarity: two products are defined as close if they belong to the same two-, four-, or six-digit product code. These definitions capture a range of distances across two products.[26]

We implement this idea by decomposing our variable capturing firm-specific exchange rate shocks. In principle, these shocks can initiate in products that are close or distant to the product being analyzed and we decompose firms' overall shocks into two components that capture these possibilities. More formally, we note that this variable can be written as $FERShock_{it+k} = \sum_{j \in M_{it-1}} w_{ijt-1} \Delta \log \left(e_{d(j)t+k}\right)$, where M_{it-1} is a set including all markets $j = p \times d$ (product × destinations) that firm i exported to during semester $t-1$, w_{ijt-1} is the initial share of exports from the firm coming from market j during semester $t-1$, and $\Delta \log \left(e_{d(j)t+k}\right)$ is the log change of the exchange rate from destination $d(j)$ between semesters $t-1$ and $t+k$. This variable can be expressed as the sum of $CloseShock_{ipt+k}$ and $DistantShock_{ipt+k}$, which include all terms in the previous expression (with the same weights) from close or distant products, respectively.[27]

[26] For example, two two-digit product codes (61-62) capture most apparel and clothing products (excluding footwear). Within one of these two groups (61), one four-digit code (61.10) includes sweaters, pullovers, sweatshirts, or similar items knitted or crocheted. Different six-digit codes in this subgroup then include sweaters made of wool (6110.11), cashmere (6110.12), or cotton (6110.20).

[27] Note that the weights w_{ijt-1} used to calculate close and distant shocks capture the relevance of each market for the firm's overall exports (and balance sheet) and do not necessarily add up to one in the subgroups of close or distant

Differences across firms in their exchange rate shocks must be driven by one of these two components and we separately estimate their effects using the specification:

$$ProdExpGrowth_{ipdt+k} = \alpha_{pdt} + \beta_1 \times CloseShock_{ipt} + \beta_2 \times DistantShock_{ipt} + \gamma_0 \times CloseShock_{ipt+1} + \gamma_1 \times DistantShock_{ipt+1} + \gamma_2{}' X_{ipdt} + \varepsilon_{ipdt}, \quad (3)$$

where $CloseShock_{ipt+k}$ and $DistantShock_{ipt+k}$ are explained above and all other variables are defined in the same way as equation (2). The two coefficients of interest (β_1 and β_2) isolate the effects of temporary shocks to other export destinations that originate in close or distant products.

Panel A of Table 5 reports the results. We find that spillover effects across firms' export destinations are important both when temporary shocks to other destinations originate in close products, and when they originate in distant products. The results for distant shocks show that our previous findings become stronger and can be estimated using only spillovers from distant products and associated with weaker economic links. Crucially, we formally analyze the difference between the effects for close versus distant shocks and find that close shocks lead to weaker (less positive) spillover effects. These key findings are robust across the three measures of product distance or similarity that we analyze. In the Internet Appendix, we show a similar pattern for the firm spillover effects in Table 2: these effects are also weaker when products are closer. This analysis provides direct evidence that economic links across markets lead to negative firm spillover effects.

3.5. Firm Spillover Effects: The Role of Firm Balance-Sheet Conditions

To provide additional evidence on the mechanism driving our results, we show that the previous spillover effects are related to the importance of balance-sheet effects. We start by checking if shocks only lead to these spillover effects when they have significant effects on firms' total exports and hence matter for firm balance sheets. To implement this idea, we consider spillover effects within a firm and product (product code). Shocks to other markets within the same product might have or not significant effects on total firm exports, depending on the importance of the product and what happens to all other products. We initially estimate a specification equivalent to equation (2), where we replace $FERShock$ with $ProdERShock,$ the weighted average of log changes in

markets. Depending on the importance of the affected markets for the firm, shocks to close or distant products can have different implications for the firm's overall balance sheet and these measures capture this point.

exchange rates across export destinations for the firm's product (using firm × product initial export shares as weights). Our previous analysis suggests that temporary shocks to economically close markets (with the same product) are associated with significant positive spillover effects (see Section 3.4). This effect is a combination of balance-sheet and economic spillover effects. If this positive spillover effect is driven by changes in firm balance-sheet conditions, this positive effect should become negative once we control for the overall shock to firm exports during semester t ($FERShock_{ipt}$). In a balance-sheet mechanism, the shock to close markets matters through changes in $FERShock_{ipt}$. After we control for this firm-level shock, we are conditioning on balance-sheet conditions and shocks to close markets isolate the effect of economic spillovers. Our previous analysis implies that we should estimate a negative spillover effect in this case. Panel B of Table 5 reports the results, which confirm this important prediction.

We then examine a central prediction from our mechanism: leverage should be a central factor explaining the magnitude of the positive spillover effects we document. As discussed in Section 2, because of fixed obligations (operating and financial), changes in sales have a levered effect on their internal funds and subsequent export capacity, i.e., a one percent change in sales can lead to a significantly larger percentage change in the available internal funds. We focus on operating leverage and check if our results are stronger when firms have higher fixed operating costs (wages). This focus on operating leverage and labor costs is motivated by the following considerations. First, when we develop a quantitative model of our mechanism, operating leverage is a key determinant of spillover effects (see Section 4). In our framework, what matters is the total leverage of the firm, i.e., the importance of all fixed obligations relative to sales. Using detailed information on the cost and financial structure of firms, we find in Section 4 that fixed operating obligations and labor costs are important. This importance of operating leverage and labor costs in shaping firm balance sheets is also highlighted by Favilukis, Lin, and Zhao (2020).

A second motivation to focus on operating leverage is the fact that our framework does not predict a clear link between our effects and the importance of financing constraints or financial leverage. Since funding constraints are a necessary condition for our mechanism, when firms are more likely to face these constraints, there is a higher probability that our mechanism is present. However, stronger constraints mean that firms have less access to credit and can leverage less (lower financial leverage). Therefore, when present, our mechanism can be weaker among firms

facing greater constraints. In other words, higher financial leverage can capture both a lower probability of funding constraints and more levered effects (when present).[28] In contrast, operating leverage is not directly related to access to finance and only captures more levered effects.

Motivated by these points, we examine the link between our results and firm wages (right before the shock) by estimating the effect of temporary exchange rate shocks separately for each tercile of $Firm\,Wage(t-1)$. We interact the two variables capturing exchange rate shocks ($FERShock(t)$ and $FERShock(t+1)$) with $High\,Wage$, $Middle\,Wage$, and $Low\,Wage$, and also include these firm wage variables without interactions (in addition to the product × destination × semester fixed effects). When defining terciles for this and other firm characteristics, we use the firm-level sample described in Panel C of Table 1. Table 6 reports the results. Column (1) shows the effects for these three separate groups. This result shows that the importance of the previous effects is strongly related to higher firm wages. In column (2), we estimate the differential effects across these groups and confirm that the effects are both economically and statistically stronger for firms with higher wages. We then show that this differential effect remains important after controlling for differences in size and age across firms. This addresses a concern that this differential effect could capture such basic firm characteristics typically associated with financing constraints. Moreover, we also find that the firm spillover effects from Table 2 are stronger for firms with higher wages (see the Internet Appendix). This analysis supports the prediction that our results should be strongly linked to the importance of operating leverage.

In the Internet Appendix, we also show that our results remain stable across different terciles of firm size and age, two key firm characteristics typically associated with financing constraints. As highlighted above, this finding is consistent with our framework. This pattern also highlights that our results are important for a broad range of firms in our setting, including large firms. This implies that funding frictions associated with production are important for large and old firms in our sample, an idea consistent with previous research. For example, the evidence in Almeida, Carvalho, and Kim (2024) and Matray et al. (2025) suggest that these funding constraints associated with production remain important even among many publicly traded firms in the U.S.

[28] A related point is that, in our framework, there is an unclear link between our mechanism and the relative importance of working capital requirements for a market (e.g., because of distance). Indeed, Paravisini et al. (2015) provide evidence that the effect of credit supply shocks on exports is unrelated to the importance of such requirements.

Relatedly, we find that our results remain similar when estimated excluding the period around the 1998 Russian financial crisis (see the Internet Appendix).

3.6. Firm Spillover Effects: Longer Time Horizons

We study the persistence of firm spillover effects and other additional implications from our mechanism. When this mechanism is important, temporary shocks to export markets can lead to spillover effects that persist over a few years. We test this implication by analyzing the previous results with outcome variables that track a three-year time horizon: $ProdExpGrowth(t)$ to $ProdExpGrowth(t+5)$. Tracking future outcomes over a longer horizon leads to a shorter sample period and we use this same period for all results. Table 7 shows the results of Table 4 using this longer time horizon. We estimate the average effect both immediately after the shock (previous results) and in the subsequent period. Figure 3 shows the results by semester. This analysis shows that spillover effects from temporary shocks are highly persistent after the shocks have ended and do not become economically weaker over time, e.g., the estimates in columns (5) and (6) are similar to and slightly stronger than the ones in columns (3) and (4), respectively.

This analysis also helps us further address a concern that our results could be rationalized by economic spillovers. In principle, economic links could explain spillovers effects after temporary shocks if there are adjustment costs. If firms expand their labor or capital during temporary shocks, these costs could lead these responses to persist after the shock and propagate across export markets. Our previous evidence on the mechanism driving our results addresses this possibility (Sections 3.4 and 3.5). This strong persistence of our results, which do not become weaker over two to three years, further addresses this issue. In the presence of adjustment costs, a short-lived shock could have persistent effects, but one would expect firms to gradually adjust back over time. Crucially, we also note that the export effects we document are economically strong. Adjustment costs could only rationalize such strong effects of short-lived shocks if there are significant and sharp responses of labor and capital during these shocks. However, adjustment costs should limit firms' ability to sharply adjust their labor and capital in response to these shocks in the first place. Indeed, in the Internet Appendix, we show that firms do not significantly expand their labor and total number of plants during these short-lived shocks. Consistent with our mechanism, and in contrast with this alternative explanation based on adjustment costs, only firms' exports respond in this sharp way to shocks.

We also replicate our findings on the role of economic links and operating leverage (Tables 5 and 6) using this longer time horizon. Tables 8 and 9 show the key results and the remaining analysis is shown in the Internet Appendix. Our previous findings remain similar over this longer time horizon. Finally, we consider the implications of our effects for domestic sales. An important point for the economic significance of the mechanism we propose is that funding frictions also affect firms' domestic sales. While we do not observe domestic sales, in the Internet Appendix. we show that our results remain economically and statistically significant when we focus on exports to countries that border Brazil and are geographically close. We also note that previous research has provided evidence that funding issues matter for domestic sales.[29]

3.7. Estimating Financial Multiplier: IV Approach

Our previous analysis of temporary shocks suggests that the spillover effects associated with these shocks are driven by firm balance-sheet effects (see Sections 3.3 to 3.6). Under this assumption, we can estimate the magnitude of the financial multiplier we propose. This multiplier captures the percentage change in exports during semester t + k in response to a temporary change of 10 percent in exports during semester t (through a balance-sheet effect). We estimate this multiplier using the following specification:

$$ProdExpGrowth_{ipdt+k} = \alpha_{pdt} + \beta \times FExpGrowth_{it} + \gamma' X_{ipdt} + \varepsilon_{ipdt}, \quad (4)$$

where $FExpGrowth_{it}$ is the firm-level export growth of firm i between semesters $t-1$ and t and all other terms are defined in the same way as in equation (2). The coefficient of interest is β and measures an elasticity of exports in semester $t+k$ with respect to firm exports during semester t. We estimate this elasticity using an IV approach where the first stage is given by specifications in Table 2. Specifically, we use $FERShock\ (t)$ as an instrument for $FExpGrowth\ (t)$, while controlling for $FERShock\ (t+1)$ (Model 1) or controlling for a third-degree polynomial function of $FERShock\ (t+1)$ (Model 2). In this approach, we are estimating an elasticity of firm exports in semester $t+k$ with respect to temporary shocks to firms' total exports during semester t. As before, to ensure that we capture firm-level effects, we weight the observations using the initial share of the product × destination for the firm's total exports during semester $t-1$.

[29] For example, see Behrens, Corcos, and Mion (2013), Berman, Berthou, and Héricourt (2015), Almeida, Carvalho, and Kim (2024) and Drechsler, Savov, and Schnabl (2024).

Table 9 reports the results. Figure 4 shows the estimates separately for each semester. We estimate elasticities that are between 0.35 and 0.60. For example, the result in column (2) implies that firms expand their exports by 4.3 percent (in existing markets) during semester $t + 1$ in response to a temporary increase of 10 percent in their exports during semester t (through a balance-sheet effect). The results show that these estimated elasticities are economically important. In the Internet Appendix, we show that this estimated elasticity is stable across a range of specifications, including alternative measures for export growth and product definitions.

4. Model, Quantification, and Broader Implications

4.1. Model Overview

We build and calibrate a model of the financial multiplier mechanism we propose and start by briefly explaining the key aspects of this model. We analyze a partial equilibrium model of a firm selling in multiple export destinations and a domestic market. In our mechanism, sharp fluctuations in exports capture shifts in the firm's level of exports in *existing* markets, which interact with their balance sheet conditions. Our focus on this margin of adjustment for exports, as opposed to entry decisions in new markets, is motivated by its importance in driving fluctuations in export activity.[30] As the firm's financial conditions suddenly change, the firm can finance more or less of variable production factors, which can be quickly adjusted, i.e. its production capacity sharply changes. To capture this idea in tractable way, we assume that the firm produces using both variable inputs (e.g., materials) that can be freely adjusted and fixed inputs (e.g., capital) that cannot be adjusted. We also assume that the set of markets in which the firm operate is fixed. To continue operating in these markets in each period, the firm needs to incur fixed costs.[31] As motivated in Section 2, the firm finances its inputs prior to the collection of cash from sales and relies both on internal funds and short-term credit to finance these working capital requirements. These fixed operating costs and financial obligations lead to an overall leverage effect which, combined with the flexible adjustment of the level of production, is key for the quantitative importance of the mechanism we study.

[30] For example, see Bernard et al. (2009), Bricongne et al. (2012), and Behrens, Corcos, and Mion (2013). We have also replicated this last finding from the literature in our data, i.e. that intensive margin changes to exports (within a firm × product × destination) are key determinants of export short-term fluctuations (over a few years).

[31] We build our analysis in such a way that is optimal for firm to continue operating in these markets. We consider a steady state and responses around this steady state where this decision is optimal. These longer-term investments associated with entry and fixed factors are important for the dynamics of exports over longer time horizons.

To introduce the financing of production in a parsimonious way, we assume that the firm needs to finance all the variable inputs upfront and that this is the case when selling both to foreign and domestic markets. The key assumptions we need are that the firm must finance a significant fraction of these variable inputs when scaling up their sales, and that this condition is relevant for both foreign and domestic markets (not necessarily with the same requirements). Another important point is that we consider a model with flexible prices and do not rely on specific assumptions about the currency used for invoicing. The main results from this analysis can be derived in a framework with sticky prices and a dominant currency, if demand conditions in specific destinations can influence their export prices (in the producer's currency).[32] Motivated by previous research documenting and discussing the limited importance of hedging in practice, we also abstract away from hedging in our model (see Section 2.3).

4.2. Model Structure

We consider a firm that sells differentiated products to $N + 1$ markets: one domestic or home market (H) and N different foreign markets. We denote the set of all markets and foreign markets using M and F, respectively. When producing for each market i, the firm uses capital (K_i^t), labor (L_i^t), and materials (m_i^t), to produce $Q_i^t = A_i^t (K_i^t)^{\tilde{\alpha}} (L_i^t)^{\tilde{\beta}} (m_i^t)^{\tilde{\theta}}$ units of a differentiated product sold in the market, where $\tilde{\alpha} + \tilde{\beta} + \tilde{\theta} \leq 1$. We model a gross production function because of the central role of variable inputs in our analysis. Firms face monopolistic competition in each market i with an isoelastic demand for its product in that market given by $Q_i^{Dt} = B_i^t (p_i^t)^{-\varepsilon}$, where p_i^t is the market-specific price set by the firm in terms of the domestic currency. The total revenue of the firm in each period is then $R_t = \sum_{i \in M} p_i^t Q_i^t$. As in traditional models of trade, we abstract away from economic links across production decisions in different markets by assuming that they are separable. However, funding frictions in this set up lead to connections across production decisions in separate markets and a tractable (Cobb-Douglas) firm-level production function.

We capture fixed inputs by assuming that $K_t = \sum_{i \in M} K_i^t$ and $L_t = \sum_{i \in M} L_i^t$ are fixed and given by K and L, respectively. We also assume that the allocation of capital $\{K_i^t\}_{i \in M}$ is fixed and consider scenarios where the allocation of labor is both fixed and variable (subject to the fixed

[32] In the Internet Appendix, we explain this point and provide direct evidence that this effect of demand conditions on export prices is economically important in our empirical setting (consistent with previous research). In our model, this price effect ensures that shocks to demand conditions immediately shift the internal funds available for exporters.

value of L_t). Given the importance of variable versus fixed inputs, we also consider an extension of our model where there are two types of labor: variable labor (modelled as flexible) and fixed labor (modelled as fixed). Following the trade literature, when selling in each market, the firm also faces market-specific iceberg trade costs, a share of output τ_i is lost while selling to market i, and market-specific fixed operating costs F_i. We also allow for the possibility of a firm-level fixed net cost T, which might be positive and negative, and could capture costs such as fixed long-term debt payments. While wages are the same across markets and given by w, we allow the price of materials p_i^m to be market specific. Additionally, to keep each unit of its capital stock, the firm needs to incur investments and maintenance costs each period given by δ. The total operating fixed cost faced by the firm in each period is given by $F = \sum_{i \in M} F_i + T + wL + \delta K$. The motivation for this set up is not that these costs are literally fixed, but that these costs do not adjust as quickly as variable inputs.[33] Motivated by our empirical setting, we model taxes as sale taxes ($\emptyset$ share of sales). We denote after-tax sales in each market as y_i^t and total after-tax sales as $y_t = \sum_{i \in M} y_i^t$.

At the beginning of each period t, the firm starts with a net worth given by w_t (liquid assets) and purchases the inputs m_t^i for its production in all markets. For expositional reasons, we relabel material costs $p_i^m m_i^t$ as m_i^t and note that we can rewrite production functions in terms of these new m_i^t variables. To help finance these input costs, the firm can issue l_t in short-term credit. At the end of the period, the firm collects the cash from sales in all markets, pays all fixed costs, and makes a short-term debt repayment given by $b_t = Rl_t$, where R is the risk-free rate. We capture funding frictions by assuming that the firm has an imperfect ability to credibly repay lenders and faces a borrowing limit (maximum credible repayment) given by $\bar{b}_t = \alpha m_t$, where $m_t \equiv \sum_{i \in M} m_i^t$. Intuitively, as firms buy more inputs, they have more assets and cash flows from sales that can be used to repay lenders. Our main points remain similar if we also link this borrowing limit to other factors such as firm sales and fixed assets. This set up is tractable because it implies that firms can externally finance a constant share (given by α/R) of each new dollar of short-term investment in inputs m_t. In the case with labor reallocation, we assume that the firm can reallocate its workers (without frictions) across its markets when it makes input decisions. Additionally,

[33] As explained below, we calibrate the model to capture the empirical importance of these fixed obligations and consider the sensitivity of our analysis to definitions of variable/fixed costs. Note that T can include non-operating costs. For simplicity, we refer to the total cost F as operating to differentiate between these costs and fixed obligations associated with short-term credit, which are endogenously determined.

following Kiyotaki and Moore (1997, hereafter KM), we assume that, at the end of each period, the firm must pay a share $0 < \gamma < 1$ of the available internal resources. This limits the ability of the firm to get out of funding constraints by saving over time. At the end of period t, the value of w_{t+1} is then determined as $w_{t+1} = (1-\gamma)(y_t - F - b_t)$.

The firm maximizes the present value of dividends which, in our setting, is equivalent to maximizing the value of dividends in each period. We consider a firm that faces a binding borrowing constraint (BC). The firm would like to expand m_i^t in each market but cannot because of the borrowing limit. This (BC) constraint is given by $m_t = w_t/(1-\alpha/R)$. In the case without labor reallocation, the firm's problem is the choice $\{m_i^t\}_{i\in M}$ that maximizes $(y_t - F - b_t)$ given (BC). In the case with labor reallocation, this problem becomes the choice $\{m_i^t, L_i^t\}_{i\in M}$ that maximizes $(y_t - F - b_t)$ given (BC) and $\sum_{i\in M} L_i^t = L$.[34]

In the Appendix, we show the solution to the firm's problem in both cases. In the case without labor reallocation, we can write the firm's (after-tax) revenue function in market i as $y_i^t = C_i^t (m_i^t)^\theta$, where $\theta = [\varepsilon/(1-\varepsilon)]\tilde{\theta}$ and C_i^t is determined by demand and productivity conditions (B_i^t, A_i^t) and the other parameters. In the case with labor reallocation, we have $y_i^t = C_i^t (L_i^t)^\beta (m_i^t)^\theta$, where $\beta = [\varepsilon/(1-\varepsilon)]\tilde{\beta}$ and C_i^t is determined in an analogous way. In both cases, changes in the economic conditions faced by the firm are fully captured by $\{C_i^t\}_{i\in M}$. Moreover, conditional on the value of other parameters, there is a one-to-one mapping between C_i^t and B_i^t (demand conditions), and one can interpret shocks to demand conditions as shifts in C_i^t. We also have that $y_t = \pi_t (m_t)^\theta$ or $y_t = \pi_t (m_t)^\theta (L)^\beta$ at the firm level, where π_t is determined by the optimal allocation of resources inside the firm and depends on $\{C_i^t\}_{i\in M}$ and the other parameters.

4.3. Firm Response to Shocks

We analyze how the firm responds to an unexpected shock at $t = 0$. We assume that the firm is initially in a constrained steady state at the end of $t = -1$, i.e., a steady state where a firm faces binding working capital constraints as outlined above. In the initial steady state, the value of $\{C_i^t\}_{i\in M}$ is fixed and all endogenous variables have constant values over time. For any variable x,

[34] The expression for (BC) comes from $m_t = w_t + \bar{b}_t/R$ and $\bar{b}_t = \alpha m_t$. Notice that, in both cases, the firm maximizes y_t since (BC) implies that $b_t = \alpha w_t/(1-\alpha/R)$. The firm allocates its scarce internal funds w_t to fund production for the markets with highest profitability. See the Appendix for more details.

we denote its value in this steady state as x_I. We consider a marginal shock at $t = 0$ to the current and future values of export conditions $\{C_i^t\}_{i \in F}$ and model this shock using a parameter φ, i.e., we assume that $\{C_i^t(\varphi)\}_{i \in F}$ for $t \geq 0$. As discussed above, we interpret these shocks as capturing changes in demand conditions $\{B_i^t\}_{i \in F}$, which could be driven by factors such as market-specific exchange rates (as in our empirical analysis). Note that, conditional on p_i^t, defined in terms of the exporter's domestic currency, an appreciation of the foreign exchange rate in a foreign market i leads foreign customers in this market to pay a lower price for the product in their own currency.[35]

More formally, we use the notation $\epsilon(Y, X) \equiv \frac{\partial Y}{\partial X} \times \frac{X}{Y}$ to capture elasticities and define shocks as $\{\delta_i^t\}_{i \in F}$ for $t \geq 0$, where $\delta_i^t = \epsilon(C_i^t, \varphi)$. We focus on the effect of shocks on the level of exports to foreign market i over time: $Export_i(t) \equiv \epsilon(y_i^t, \varphi)$. Note that, while y_i^t is determined after a sales tax, this elasticity is the same for the pre-tax value of exports measured in the data. Similarly, we define the effect on total exports as $TotExport(t) \equiv \epsilon(y_E^t, \varphi)$, where $y_E^t = \sum_{k \in F} y_k^t$. For expositional reasons, we focus on a symmetric steady state, where all foreign markets have the same value for C_i^I, what leads these markets to have the same markets shares. We denote the share of total exports in y_I using $0 < s_I^E < 1$. We contrast these responses to shocks by constrained firms to the one from an unconstrained counterfactual, where firms face no limit in their ability raise short-term funding and finance their production, but are otherwise exposed to the same frictions (e.g., fixed capital) and parameter values. In this counterfactual, we assume that firms are initially in an unconstrained steady state when hit by the same unexpected shock. We denote this counterfactual response using $Export_i^u(t) \equiv \epsilon\left(y_{u,i}^t, \varphi\right)$, where $y_{u,i}^t$ is the unconstrained firm's (after-tax) exports. Shocks are not associated with any firm spillover effect in this benchmark. We describe below the key findings and provide more details in the Appendix.

To illustrate the financial multiplier effect we propose, we first consider the effect of a temporary shock to a single export market i: $\delta_i^0 = \delta$ and $\delta_j^t = 0$ if $t \geq 1$ or $j \neq i$. This shock leads to initial effects on total exports ($TotExport(0) = \delta_E$ has the same sign as δ), and the firm's subsequent balance sheet (w_1). Crucially, as balance-sheet conditions shape firms' ability to

[35] When a market-specific exchange rate appreciates (depreciates) there is a higher (lower) demand for the product given p_i^t, which is equivalent to an increase (a decrease) in B_i^t. Note that the elasticity of demand ε should not change with this shift in the exchange rate. Given any exogenous value for the firm of this exchange rate, a 1 percent increase in p_i^t leads to a one percent increase in the price paid by foreign customers in their local currency.

finance new export transactions in subsequent periods ($t \geq 1$), the initial shock to exports is propagated to all export markets in these periods. This financial multiplier effect is given by $Export_k(t) = P_t \times \delta_E$ for all foreign markets k in $t \geq 1$. The multiplier $P_t > 0$ captures the percentage change in exports during period $t \geq 1$ in response to an initial change in exports of 10 percent in period $t = 0$. This multiplier effect leads to positive firm spillover effects in subsequent periods ($t \geq 1$). Because of this mechanism, funding frictions can significantly amplify and prolong the effect of the temporary shock on exports over a few periods. However, these frictions do not amplify the immediate response to the shock during $t = 0$. In this initial period, funding frictions can only limit firms' ability to respond to the shock. Relatedly, this shock leads to negative or no significant firm spillover effects in the initial period.[36]

We show that this financial multiplier is given by $P_t = \theta \times n^{t-1} \times M \times s_I^E$, where $M = [1 - \alpha v_I - f_I]^{-1} > 1$, $v_I = m_I/y_I$ is the ratio of variable costs to (after-tax) sales, and $f_I = F/y_I$ is the ratio of fixed costs to (after-tax) sales. This expression remains the same with and without labor reallocation. An initial shock to exports of 10 percent will only affect the firm's total sales by $10 \times s_I^E$ percent. However, the effect on firms' internal funds (w) is levered by both operating and financing fixed obligations (f_I and αv_I), what leads to a total leverage effect captured by $M > 1$. An initial change of $10 \times s_I^E$ percent on sales will then affect w by $10 \times M \times s_I^E$ percent. The term n captures the extent to which an initial shock to w_t translates into subsequent changes in w_{t+1} and can be determined using (v_I, f_I, α, θ). This term can lead to a significant persistence of multiplier effects ($n \geq 1$) because funding frictions also shape domestic production, and the leverage associated with fixed operating costs (firms adjust their short-term debt after the initial period). The term θ is the elasticity of firm sales with respect to changes in the variable inputs.

We then consider general shocks to export markets and the role of the previous financial multiplier in amplifying and prolonging their effects. Shocks can now affect export demand conditions across multiple periods and markets, and multiplier effects need to be aggregated. As we consider marginal shocks, one can simply add the previously analyzed effects for each change

[36] We have that $Export_j(0) \leq 0$ for $j \neq i$. When faced with better opportunities in market i at $t = 0$, the firm has incentives to reallocate funds from other markets into market i, what leads to the negative spillover. Since the shock is short-lived, the firm might be unable to quickly respond and reallocate resources during $t = 0$. The fact that the firm can reallocate resources across domestic and export markets also reduces this negative effect of funding frictions on its ability to respond to export shocks.

in demand conditions. This overall effect is now based on a combination of the previous multipliers P_t and can significantly amplify firms' responses to shocks if these multipliers are economically important.[37] Moreover, the importance of this amplification mechanism is related to the presence of significant positive firm spillover effects in firms' responses to shocks. In our framework, only the financial multiplier effect leads to positive firm spillovers. When the multipliers P_t are not economically important, funding frictions limit firms' ability to respond to shocks to exports. In this scenario, firm spillover effects are negative and capture the competition for scarce funds across the different markets from the exporter. Importantly, we calibrate our model and simulate these effects to analyze which of these possibilities is implied by the data.

4.4. Model Calibration

To calibrate our model, we match key moments highlighted by our analysis and use a few previously estimated parameters. We build on detailed information on the cost and financial structure of firms in our setting. In the Appendix, we show how the responses to shocks of constrained and unconstrained firms described above can be determined using closed-form expressions that depend on a few key parameters and moments: $(v_I, f_I, \alpha, \theta, \beta, s_I^E, N)$. These expressions are analogous to the one above for P_t. The role of these moments and parameters in shaping firms' responses to shocks is intuitive. The importance of fixed obligations and leverage (operating and financial), which play a central role shaping the magnitude of our mechanism, is captured by (v_I, f_I, α). θ and β are key parameters from the firm's revenue function, which determine how the adjustments to inputs matter for sales. s_I^E and N determine the overall importance of exports relative to domestic sales and the size of individual export markets. Our calibration uses plausible estimates for these key parameters (in this list) and then, when estimating the remaining parameters, ensures that our model matches the values for these key moments in our empirical setting. We note that the results from our model are eventually determined by these central inputs of our calibration.

We use data and parameter estimates for manufacturing, which typically captures a large share of export activity and presents approximately 80 percent of the number of exporters or the value of exports in our setting. We provide more details on this calibration in the Appendix and here

[37] For example, suppose an export demand shock has direct effects on total exports during periods $t = 0$ and $t = 1$ given by δ_E^0 and δ_E^1, respectively. The total multiplier effect in period $t = 2$ will then be $\delta_E^0 P_2 + \delta_E^1 P_1$.

highlight the following points. The parameters (θ, β) directly map into estimated parameters of revenue-based production functions in industrial organization. We rely on estimates from Gandhi, Navarro, and Rivers (2020), which consider multiple approaches to estimate gross production functions, and provide estimates with data from Chile and Colombia. We measure N using the average number of product-destinations by exporters in our data. We then rely on detailed information on the cost and financial structure of firms in our setting to analyze $(v_I, f_I, \alpha, s_I^E)$. We identify α using the fact that $\alpha = (l_I/m_I) \times R$ in our model, where l_I/m_I is the share of working capital requirements financed externally with short-term credit (from different potential sources). To measure this share, we rely on firm-level data on Brazilian exporters from the World Bank Enterprise Surveys (WBES), which directly collects information on this share and the sources of funding for firms' working capital requirements. We also use these surveys to measure the ratio of exports to total sales for Brazilian exporters (s_I^E). Finally, we use detailed information on the cost structure of manufacturing firms from annual manufacturing surveys collected by the Brazilian Statistical Agency (IBGE). This data allows us to measure different types of material costs, labor costs, capital depreciation and capital maintenance costs, taxes, and sales for the average Brazilian manufacturing firm. We use this information to construct measures of v_I and f_I equivalent to the ones in our model.

4.5. Model Simulations

Using our calibrated model, we simulate the effects that we analyze in our empirical results. This analysis allows us to check if our empirical findings can be both qualitatively and quantitatively explained by the mechanism we propose. We highlight that we do not use any of our empirical results as targets in the calibration of our model. We start by simulating the multipliers P_t for semesters $t+1$ to $t+5$, which can be directly compared to the ones we estimate in Section 3.7 and Table 9 using our refined empirical analysis. Panels A and B of Table 11 show these simulated effects from the model and report the counterparts from our empirical analysis (IV estimates). Figure 4 reports these simulated effects and empirical counterparts separately for each semester. This analysis shows that estimates from the model quantitatively match the significant economic magnitude from the multipliers we estimate. To understand this significant economic magnitude, it is helpful to rely on the expression $P_1 = \theta \times M \times s_I^E$ (see Section 4.3). While exports represent only 20 percent of total sales (s_I^E), the data implies that firms

are exposed to significant fixed obligations (operating and financial) that lead to a large total leverage effect (M) and that variable inputs are important determinants of firm sales (θ), what leads to $\theta \times M = 2.2$. Both fixed operating costs and the significant share of firms' working capital financed externally (53 percent) play a quantitatively important role in driving this total leverage effect.

As in our empirical findings, the model generates effects that have a strong persistence over time and do not become weaker over a few semesters. In our calibrated model, this result comes from the importance of operating leverage and the fact that domestic sales are also affected by production funding issues.[38] In the Internet Appendix, we show that these main finings remain present in a version of our model where some of the firm's labor is also modelled as a variable input (that can be adjusted after the initial shock). While the presence of this variable input reduces operating leverage over time, it also provides one additional margin for firms to adjust their production scale, what contributes to a stronger multiplier effect.[39]

We then use our model to examine if these multiplier effects, that we isolate in the data with our refined evidence, can rationalize the broader patters we document on the importance of firm spillover effects. To simulate firm spillover effects, we need to specify a shock, and we consider the shock implied by our empirical results in Table 2. Specifically, in the Appendix, we show how to recover the shock to export demand conditions implied by Table 2 using our results on direct effects and the calibrated model. This analysis does not use information from our estimated firm spillover effects or total effects. We then use this implied shock to simulate the firm spillover effects predicted by our model, which can be directly compared to the spillover effects in our empirical results. We simulate spillover effects under two scenarios: one without internal labor reallocation and one with internal labor reallocation across markets. These simulated spillover effects capture both the positive firm spillovers associated with the financial multiplier and the negative firm spillovers discussed in Section 4.3. Recall that our mechanism only leads to firm spillovers from semester $t+1$ on (after a shock in semester t). While we find some positive estimates for spillover effects in semester t, these effects are not robust or statistically significant

[38] Firms can adjust their short-term debt after the initial period. However, during this period, changes in firms' internal funds shape their production capacity across multiple markets and operating leverage still leads to leverage effects.
[39] See the Appendix for a more detailed discussion. This point is different from the one considered in Section 3.5 that higher operating costs (due to higher wages) should be an important determinant of stronger multiplier effects.

across specifications. Panel C of Table 11 shows firm spillover effects from both this simulation and our empirical analysis. We focus on firm spillover effects between semesters $t+1$ and $t+5$. Our model predicts an average positive spillover effect with a significant economic magnitude, close to the one we empirically estimate. This significant positive firm spillover effect reflects the importance of the financial multiplier previously analyzed. This finding also reflects the reduced magnitude of negative firm spillovers in our simulation. Since exports only represent a share of total sales (20 percent) and constrained firms can reallocate their internal funds from domestic production to foreign markets, this limits the competition for scarce funds within export markets. Panel D shows this analysis for the total effects of the shocks.

We note that there is small difference between the dynamics of firm spillover effects in our model and the data: these effects increase more gradually over time in our model. We first highlight that our empirical findings are not precise enough to capture in detail these dynamics across semesters (as opposed to average effects across multiple semesters). Additionally, we note that we simplify some aspects of our model for tractability reasons and that one could build a more complex version of our model to better capture these dynamics. For example, we could model firms' borrowing as also shaped by firm cash flows, what would lead to faster responses of firm balance sheets and spillover effects in response to demand conditions.

Overall, we conclude that our empirical results can be quantitatively explained by the financial multiplier effect we propose. This is the case both for our refined evidence and the broader patterns we document on the importance of firm spillover effects.

4.6. Quantification and Broader Implications

As a final step in our analysis, we quantify the role of funding frictions in the amplification of shocks to exports. We implement this quantification exercise using two alternative approaches: we use our calibrated model to simulate counterfactuals, and we use simple calculations based on our empirical results and a few assumptions motivated by our model. In our first approach, we simulate a counterfactual scenario in our model where the firm is not exposed to working capital funding issues (as described in Section 4.3). In this counterfactual, there is no borrowing limit for the firm's short-term credit and the firm can finance its production without frictions, but the firm is otherwise exposed to the same frictions and parameter values as in our baseline analysis. Figure 5 shows the firm's simulated responses under these two scenarios (constrained and unconstrained). We

implement this analysis for both the case with internal labor reallocation and the case without this reallocation, and use the shocks implied by our results (see Section 4.5). The simulation shows how the effect of shocks to exports is significantly amplified by the presence of working capital financing frictions. While the response of the unconstrained firm is slightly stronger in the initial semester of the shock (semester t), when the financial multiplier is not present, our mechanism leads to a significantly stronger response afterwards. To quantify this amplification, we compare the average effect of the shock between semesters t and $t+5$, and estimate that the constrained firm's response is 57 to 68 percent stronger during this three-year period (across both scenarios).

To help interpret this analysis, we note that the unconstrained firm's response to the shock is approximately the same as the direct effect of the shock for the constrained firm. This follows from the point that, since the firm operates in several markets in our data (and model), funding constraints do not significantly limit the firm's ability to (marginally) expand in a single market. The firm can respond to shocks in one market by making small cuts in other ones.[40] Importantly, this point implies that the gap between the responses of constrained and unconstrained firms is captured (approximately) by firm spillover effects. Therefore, the presence of significant positive spillover effects implies that funding frictions significantly amplify the effect of shocks to exports.

We build on this insight to propose a second alternative approach to quantify the role of funding frictions in the amplification of shocks to exports. Assuming that the unconstrained response can be captured by the direct effects, we can quantify the amplification of shocks to exports by dividing our estimated firm spillover effects by our estimated direct effects of shocks (interpreted as firm unconstrained responses). Using the results from Table 2 (average values for the three years), we estimate that the constrained firm's response is 67 percent stronger during this three-year period. This amplification can now be seen by comparing the total and direct effects in Figure 2. This close magnitude between the estimates based on these two alternative approaches reflects the fact that our calibrated model predicts average responses that are close to the ones we estimate.

[40] We confirm this prediction using model simulations (Panel E of Table 11). Since the constrained firm operates at a lower scale than the unconstrained one, in principle, these direct effects of shocks for constrained firms could still be different from the response of unconstrained firms. However, we capture responses using elasticities and, in our framework, these unconstrained elasticities do not change with the scale of firms' operations (due to the Cobb-Douglas production functions with constant factor elasticities).

This analysis shows how funding frictions can significantly amplify and prolong shocks to exports. While we focus on studying firm-level effects, our findings suggest an important mechanism through which funding frictions can contribute to aggregate fluctuations in exports. As illustrated by Figure 1 and discussed in the introduction, export activity is associated with volatile cycles.[41] These fluctuations capture sharp changes in exports over a few years and are largely driven by changes in the level of exports within firms' existing export markets (as in our mechanism). When considering the contribution of our mechanism for these broader patterns, we highlight the following points. Consistent with our theory, our evidence suggests that the mechanism we study is important for a broad range of firms, including the largest firms in our setting. Additionally, our analysis focuses on the amplification of economic shocks to exports that we take as given. As discussed in the introduction, there are reasons to expect exports to be exposed to significant economic volatility, so it is natural to assume that exports are subject to shocks. While our analysis does not provide an explanation for why booms or busts in exports reverse, we can rationalize why sequences of positive and negative shocks (relative to a trend) can be amplified and prolonged, leading to more volatile export cycles. These effects can be especially important for exports, as opposed to broader economic activity, because exports are exposed to a stronger underlying economic volatility (as discussed in the introduction). Moreover, the working capital issues that we highlight might be especially important for firms in activities associated with trade such as manufacturing (e.g., in contrast with services).

5. Conclusion

This paper shows how financing frictions can significantly amplify and prolong the effect of shocks to exports. We propose and test a new financial multiplier effect leading to this effect. In this mechanism, changes in firms' exports affect their balance sheet conditions, which then shape firms' ability to finance new export transactions. To study the importance of this effect, we build on micro-level customs data covering the universe of export transactions for Brazilian firms between 1996 and 2006. Guided by a model of this mechanism, we first document an important new empirical fact that is a central prediction from this effect: the presence of significant and persistent positive firm spillover effects. These spillover effects capture the propagation of shocks

[41] Engel and Wang (2011) document this significant volatility of export cycles across a broad range of countries over decades.

to export demand conditions across the different markets of a given firm. Using an identification strategy that refines this finding, we provide reduced-form evidence on the economic importance of the financial multiplier we propose and estimate its magnitude. We then develop and calibrate a structural model of this mechanism using detailed information on the cost and financial structure of firms and show that it can quantitatively and qualitatively replicate our empirical results. Using this calibrated model and our empirical results, we quantify the role of financing frictions in amplifying the effect of economic shocks on exports.

Our analysis of the interaction between economic shocks (e.g. export demand conditions) and funding frictions faced by exporters has multiple implications. It suggests how these frictions can significantly contribute to changes in export activity even in the absence of major disruptions to the supply of credit and financial markets. It also illustrates how analyses linking funding frictions in export markets to these credit supply effects can significantly underestimate the importance of such frictions. Importantly, this analysis suggests how finance can magnify the significant volatility of export cycles that we observe. While our paper focuses on documenting and quantifying the importance of these effects at the firm level, studying the broader and aggregate implications of these considerations is an important area for future research.

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Appendix: Model and Quantification

We provide additional details on the analysis of the model and the quantification exercise.

Model Solution and Steady State

We solve the problem of the constrained firm and explain conditions that lead to the existence of a constrained steady state. We focus our analysis on responses around this steady state, where the firm's decisions are described by the solution we analyze. We start with the case without labor reallocation (the case with labor reallocation is analyzed below). We can write $y_i^t = C_i^t (m_i^t)^\theta$, where $\theta = [\varepsilon/(1-\varepsilon)]\tilde{\theta}$ and $C_i^t = f(t, \tau, \varepsilon, \tilde{\beta}, \tilde{\alpha}, L_i, K_i)\left(A_t^i\right)^{(\varepsilon-1)/\varepsilon}\left(B_t^i\right)^{1/\varepsilon}$ for some function $f(.)$. This follows from the set up assumptions (production function, demand, and other assumptions). In principle, the firm might not face binding constraints and might not to use all its internal funds w_t to invest in m_t. We allow the firm to invest a_t in the risk-free asset at the start of the period. The firm budget constraint is given by $m_t + a_t = l_t + w_t$. The firm's problem is the choice $\{\{m_i^t\}_{i\in M}, a_t, l_t\}$ that maximizes $(y_t + Ra_t - F - Rl_t)$ given this budget constraint and $Rl_t \leq \bar{b_t} = \alpha m_t$. This objective function captures the available funds at the end of the period. We note that, given a choice of $m_t = \sum_{i\in M} m_i^t$, the firm will always choose $\{m_i^t\}_{i\in M}$ to maximize y_t. The solution to this last problem (maximize y_t given m_t) is $m_i^t = s_i^t m_t$ and $y_i^t = s_i^t y_t$, where $s_i^t = \frac{\widetilde{C_i^t}}{\sum_{k\in M}\widetilde{C_k^t}}$ and $\widetilde{C_k^t} = (C_k^t)^{\frac{1}{1-\theta}}$. Using $y_t = \sum_{i\in M} y_i^t$ and this optimal internal allocation of resources we have $y_t(m_t) = \pi_t (m_t)^\theta$, where $\pi_t = \sum_{k\in M} C_k^t (s_k^t)^\theta$, i.e., the firm-level revenue function endogenously has the same factor elasticity as each market. We note that $(a_t - l_t) = w_t - m_t$ and we can rewrite the firm's problem as the choice of m_t that maximizes $(y_t(m_t) - Rm_t - F + Rw_t)$ subject to $m_t \leq w_t/(1-\alpha/R)$ and $m_t \geq 0$. The firm will face a binding borrowing constraint if $\partial y_t/\partial m_t = \theta y_t/m_t > R$ at the limit $m_t = w_t/(1-\alpha/R)$ (when w_t is low). The optimal decision is given by this binding limit in this case. We require that $y_t(m_t) - Rm_t - F \geq 0$ in this optimal decision to ensure that the firm wants to operate. In a region where the binding constraint holds, and it is optimal to operate, the dynamics of the firm is given by $m_t = w_t/(1-\alpha/R)$, $w_{t+1} = (1-\gamma)(y_t - F - \alpha m_t)$, and the optimal allocation $\{s_i^t\}_{i\in M}$.

For expositional simplicity, we focus on a symmetric steady state, where the firm has the same share of production across all export markets, i.e., we assume that $C_i^t = C$ for all export markets and $C_H^t = (1+\mu)C$ for the domestic market, where $\mu > 0$ (all other parameters have fixed values).[42] Given these values, we can define π using the expression above for π_t. A constrained steady state is a pair (m_I, w_I), where the funding constraint is binding, m_I is an optimal decision given w_I, and $w_I = (1-\gamma)(y_I - F - \alpha m_I)$, where $y_I = \pi\,(m_I)^\theta$. The dynamics around this steady state is captured by the analysis above.

We can follow analogous steps in the case with labor reallocation and write $y_i^t = C_i^t (L_i^t)^\beta (m_i^t)^\theta$, where $\theta = [\varepsilon/(1-\varepsilon)]\tilde{\theta}$, $\beta = [\varepsilon/(1-\varepsilon)]\tilde{\beta}$ and $C_i^t = f(t, \tau, \varepsilon, \tilde{\alpha}, K_i)\left(A_t^i\right)^{(\varepsilon-1)/\varepsilon}\left(B_t^i\right)^{1/\varepsilon}$ for

[42] We can implement our analysis using steady states without this symmetry and this only requires specifying a distribution for the market share of firms across markets. We also note that the optimal internal allocation implies $y_t^i/m_t^i = y_t/m_t$. This means that $\partial y_t^i/\partial m_t^i > R$ in all markets in the constrained region, i.e., the firm is constrained in each market.

some function $f(.)$. The firm's problem is the choice $\{\{m_i^t, L_i^t\}_{i\in M}, a_t, l_t\}$ that maximizes $(y_t + Ra_t - F - Rl_t)$ given the budget constraint $m_t + a_t = l_t + w_t$, the labor constraint $\sum_{i\in M} L_i^t = L$ (L is exogenous), and the borrowing constraint $Rl_t \leq \bar{b}_t = \alpha m_t$. The optimal internal allocation is now the choice of $\{m_i^t\}_{i\in M}$ that maximizes y_t given $\sum_{i\in M} m_i^t = m_t$ and the labor constraint. The solution to this problem is $m_i^t = s_i^t m_t$, $L_i^t = s_i^t L$, and $y_i^t = s_i^t y_t$, where $s_i^t = \frac{\widetilde{C_i^t}}{\sum_{k\in M}\widetilde{C_k^t}}$ and $\widetilde{C_k^t} = (C_k^t)^{\frac{1}{1-\theta-\beta}}$. Note that the optimal allocation of labor does not depend on w_t and is separable from the optimal choice of m_t. We now have that $y_t(m_t) = \pi_t(m_t)^\theta$, where $\pi_t = \sum_{k\in M} C_k^t (s_k^t)^{\theta+\beta}(L)^\beta$. The firm chooses m_t to maximize $(y_t(m_t) - Rm_t - F + Rw_t)$ subject to the limits $m_t \leq w_t/(1-\alpha/R)$ and $m_t \geq 0$. The condition for a binding borrowing constraint is the same as before: $\partial y_t/\partial m_t = \theta y_t/m_t > R$ at the borrowing limit. The dynamics of the firm is still given by $m_t = w_t/(1-\alpha/R)$, $w_{t+1} = (1-\gamma)(y_t - F - \alpha m_t)$, and the optimal allocation $\{s_i^t\}_{i\in M}$, which now also applies to labor. Note that the fixed cost F includes the total labor cost. We can define a constrained steady state using the same conditions as before for a pair (m_I, w_I).

Firms' Responses to Shocks

We analyze the firm's response to the shocks described in the text. Note that shocks to C_i^t can be interpreted as capturing shocks to demand conditions (B_i^t). As explained in the text, an appreciation (depreciation) of the currency in market i should increase (decrease) B_i^t and translate into a positive (negative) shock to C_i^t. We first consider the effect of a temporary shock to a single export market i: $\delta_i^0 = \delta$ and $\delta_j^t = 0$ if $t \geq 1$ or $j \neq i$. Suppose that the shock takes place after the production decision was made at $t = 0$. In this case, there is no effect on the firm's decision at $t = 0$, only a change to its sales and cash flows, i.e., $TotExport(0) \equiv \epsilon(y_E^0, \varphi) = (1/N) \times \delta \equiv \delta_E$ (mechanical effect on exports). This shock affects the firm's decisions at $t \geq 1$ in all markets $k \in M$ (only) through the change in w_1. Using the two conditions above for the firm's dynamics, we have that $Export_k(t) = P_t \times \delta_E$ if $t \geq 1$, where $P_t = \theta \times n^{t-1} \times M \times s_I^E$, $s_I^E = y_I^E/y_I$, $M = [1 - \alpha v_I - f_I]^{-1} > 1$, $v_I = m_I/y_I$, and $f_I = F/y_I$. We can write $n = n_0 \times M'$, where $n_0 = 1 - (1-\theta)(1-\alpha v_I)^{-1} < 1$ and $M' = 1 - [1 - f_I/(1-\alpha v_I)]^{-1} > 1$. The intuitions for the terms in this financial multiplier P_t are described in the text. The terms s_I^E and M capture the importance of exports and leverage (both operating and financial), respectively. The term n captures the persistence of the multiplier over time, which could be significant because of operating leverage and the fact that the domestic production also faces constraints. This multiplier is the same for the cases with and without labor reallocation. When production decisions are made at $t = 0$, before the shock hits the firm, this multiplier effect also remains the same. The shock now changes the firm's allocation of internal resources at $t = 0$ (m_0 is not affected due to the binding borrowing constraint). Because this allocation maximizes y_0, an envelope condition implies that the effect of the shock on y_0 and w_1 remains the same as before (without any adjustment in decisions). The only difference relative to the previous case is this initial effect on the allocation of internal resources. As the firm moves scarce funds to export market i and away from other markets during $t = 0$, this leads to a negative spillover on other export markets $j \neq i$ in this period, which can be determined using s_i^t. The immediate effect of the shock in market i during period $t = 0$ captures both the mechanical effect of the shock to C_i^0 on y_i^0 and the change in y_i^0 due to the response of m_i^0 to C_i^0. As the firm reallocates resources across markets, this amplifies the mechanical effect of C_i^0 on market i.

We then consider the effect of general shocks, which can affect several markets over multiple periods of time and can be determined using the previous expressions for y_i^t, m_i^t, m_t, and w_{t+1}. In general, we can write the firm's response as $Export_i(t) \equiv \epsilon(y_i^t, \varphi) = Direct_i^t + FinMultiplier_i^t + Reallocation_i^t$, where $Direct_i^t$ is the immediate effect (in period t) of the shock to market i during period t, $FinMultiplier_i^t$ is the overall financial multiplier effect that incorporates all the past effects of the shock on w_t, and $Reallocation_i^t$ is a negative firm spillover effect of the shock to other markets $j \neq i$ during period t. To simplify the exposition of our analysis, we consider shocks with an arbitrary dynamic over time but that symmetrically affect all the export markets of a firm. This mirrors our empirical analysis, where we focus on the effect of firm-level shocks to export markets. As we analyze the average effect of a given shock across a firm's markets, modelling an arbitrary correlation across these markets does not affect our analysis (as we show in the Internet Appendix).[43] Specifically, we model these shocks as $\delta_i^t = \delta_t$ for all export markets i and $\delta_H^t = 0$ for the domestic market.

The direct effects of shocks are given by $Direct_i^t = \delta_t \times \left\{1 + \left(\frac{\theta}{1-\theta}\right)\left[1 - \left(\frac{s_I^E}{N}\right)\right]\right\}$ in the case without labor reallocation, and by $Direct_i^t = \delta_t \times \left\{1 + \left[\frac{(\theta+\beta)}{1-(\theta+\beta)}\right]\left[1 - \left(\frac{s_I^E}{N}\right)\right]\right\}$ when there is labor reallocation. As in the previous example of a temporary shock, this direct effect captures both the mechanical effect of C_i^t on y_i^t and the change in y_i^t due to the response of m_i^t to C_i^t. When there are many export markets, this response becomes close to the one from an unconstrained firm, which is not exposed to working capital funding frictions, i.e., has a high w_t but faces all other frictions such as adjustment costs on labor and capital. We denote this response using $Export_i^u(t) \equiv \epsilon\left(y_{u,i}^t, \varphi\right)$, where $y_{u,i}^t$ is the unconstrained firm's sales to market i. In the Internet Appendix, we show that $Export_i^u(t) \approx Direct_i^t$ when N is large. This approximation is reasonable in our data, where the average export market of the typical firm represents 2 percent of total sales (20 percent of sales/10 export markets), as illustrated by our model simulations. Intuitively, when each individual export market represents a limited share of total sales, the firm can marginally expand in one market by making small cuts to inputs in each other market and the funding constraint does not limit this response.[44] The negative firm spillover effect is given by $Reallocation_i^t = -\delta_t \times \left(\frac{\theta}{1-\theta}\right)\left(\frac{N-1}{N}\right)s_I^E$ in the case without labor reallocation and by $Reallocation_i^t = -\delta_t \times \left[\frac{(\theta+\beta)}{1-(\theta+\beta)}\right]\left(\frac{N-1}{N}\right)s_I^E$ with labor reallocation. These effects capture the response of m_i^t to C_j^t for $j \neq i$. As in the case of the temporary shocks, this response leads to a negative spillover effect, which can be determined using s_i^t. Note that these reallocation effects become stronger when the firm can also shift labor across markets. Importantly, the magnitude of this effect becomes limited when exports do not represent a large share of sales. This comes from

[43] A weaker correlation across shocks to different markets changes the distribution of firm-level shocks but we focus on the effect of a given shock. Conditional on the average magnitude of such shock across markets, the distribution of this shock across markets does not change its average effect (across these markets). To connect this analysis to our empirical results, the important point is to use magnitudes for firm-level shocks that match the ones in our results.

[44] The level of exports of the constrained firm across markets is lower with high N as the firm cannot sell more in all markets. In principle, these marginal responses could be different if unconstrained responses change with the level of exports. In the framework here analyzed, this does not happen because there is a revenue function with a constant factor elasticity (Cobb-Douglas). More broadly, there is no clear reason to expect a systematic gap between these two responses outside of this framework.

the fact that, when this is the case, firms do not need to significantly cut their sales in one export market to expand in other export markets (these cuts can be shared with domestic sales).

The financial multiplier effect is given by $FinMultiplier_i^t = P_1 \times \delta_{t-1} + P_2 \times \delta_{t-2} + \cdots + P_t \times \delta_0$. Intuitively, this effect captures the sum of many potential multiplier effects that can build up, each equivalent to the one analyzed in the example with a temporary shock. Each of these multiplier effects capture a different indirect effect of the shock on w_t. As we analyze marginal effects, the total multiplier effect is the simple sum of these effects.[45]

To highlight some key points, we rely on this approximation that $Export_i^u(t) \approx Direct_i^t$. This allows us to write $Export_i(t) - Export_i^u(t) \approx FinMultiplier_i^t + Reallocation_i^t$. The first important point is that funding frictions (working capital constraints) can amplify or limit the response of exports to demand shocks. Intuitively, this amplification will happen when the financial multiplier effect is stronger than the reallocation effect: if $FinMultiplier_i^t + Reallocation_i^t \geq 0$ when $\delta_t \geq 0$ (positive shock) or $FinMultiplier_i^t + Reallocation_i^t \leq 0$ when $\delta_t \leq 0$ (negative shock). This amplification will happen when leverage effects (due to operating and financial leverage) are strong, leading the financial multiplier to become more important. Another key point is that this amplification will happen when firm spillovers across export markets are positive. Note that when the approximation above holds, shocks to one market have a limited effect on w_t, and the financial multiplier only captures spillover effects across markets. In this case, we can write $Export_i(t) \approx Direct_i^t + FirmSpillover_i^t$, where the total spillover effect of shocks across export markets is given by $FirmSpillover_i^t = FinMultiplier_i^t + Reallocation_i^t$. Therefore, funding frictions amplify shocks to export markets if and only if there are significant positive spillover effects. Moreover, the magnitude of such total spillover effects tells us the importance of these amplifications. Finally, notice that the importance of these amplification effects is tied to the importance of the financial multipliers $P_1, P_2, \ldots, P_k$ which can be estimated using the firm's response to temporary shocks (as in our empirical analysis).

One point that contributes to the magnitude of this financial multiplier effect is that internal funds are quickly affected by the shock despite the constraint faced by the firm in its ability to quickly adjust its production. This comes from the fact that export prices adjust (in the local currency) in response to the demand shock. This is natural in our model with (endogenous) flexible prices but could also hold in alternative models with sticky prices and a dominant currency. We further discuss this point and provide direct evidence supporting it in the Internet Appendix.

Model Calibration and Simulated Effects

An important point from our analysis above is that the effects and counterfactuals of interest can be determined using closed-form expressions that depend on a few key parameters and moments: $(v_I, f_I, \alpha, \theta, \beta, s_I^E, N)$. When calibrating our model, we ensure that these key parameters are identified in a clear way and use direct measures of these key moments to calibrate the remaining model parameters. As discussed in the text, we use data and parameter estimates for manufacturing, which represents most of our sample of exports (about 80 percent of the number

[45] For example, the effect at $t = 2$ captures the indirect effect of the shock on w_2. The initial effect of the shock on C_k^0 (across markets k) leads to changes in w_1 which then affect w_2 and m_2. This is captured by the term $P_2 \times \delta_0$. The subsequent effect of the shock on C_k^1 (across markets k) then also leads to propagation effects on w_2 and m_2. This leads to the additional term $P_1 \times \delta_1$ and a total multiplier effect equal to $P_1 \times \delta_1 + P_2 \times \delta_0$.

of firms, export sales, and number of transactions). Specifically, the steady state of our model is determined by the following parameters: $(\alpha, \theta, \beta, \mu, N, R, C, F, \gamma)$. The parameters (θ, β) directly map into estimated parameters of revenue-based production functions in industrial organization and we rely on estimates from Gandhi, Navarro, and Rivers (2020), based on data from Chile and Colombia. We measure N using the average number of product-destinations by exporters in our data. The share of exports s_I^E maps directly into the parameter μ as we can write $s_I^E = N \times \left[N + (1+\mu)^{1/(1-\theta)}\right]^{-1}$ or $s_I^E = N \times \left[N + (1+\mu)^{1/(1-\theta-\beta)}\right]^{-1}$ and then combine this expression with the empirical value of this share to identify μ. We use the average risk-free rate during our sample period as the value for R. We identify α using the fact that $\alpha = (l_I/m_I) \times R$ in our model, where l_I/m_I is the share of working capital requirements financed externally with short-term credit (from different potential sources). To measure this share, we rely on firm-level data on Brazilian exporters from the World Bank Enterprise Surveys (WBES), which directly collects information on this share and the sources of funding for firms' working capital requirements. We also use these surveys to measure the ratio of exports to total sales for Brazilian exporters (s_I^E). In both cases, we use average values across all manufacturing firms that are exporters and note that these values are stable across firms with different size.

These analyses allow us to uniquely identify $(\alpha, \theta, \beta, \mu, N, R)$, which we label as initial parameters. We then build on the following result, shown in the Internet Appendix: conditional on the initial parameters, there is always a unique value of all parameters that leads to a constrained steady state that matches (v_I, f_I, y_I), where $y_I > 0$ is the firm's size (total sales). This result is valid as long as two conditions hold: $v_I < \theta/R$ and $Rv_I + f_I \leq 1$ (which we check). This result allows us to construct a steady state that matches all the key moments and parameters from our analysis. Moreover, we can do this for a firm with any size, i.e., our analysis can be applied to firms with any size. Importantly, note that this choice of firm size will not affect the simulated effects from our model, which are completely determined by $(v_I, f_I, \alpha, \theta, \beta, s_I^E, N)$. Recall that v_I is the ratio of material costs to (after-tax) sales and f_I is the ratio of fixed costs (including capital and labor costs) to (after-tax) sales. We use detailed information on the cost structure of manufacturing firms from annual manufacturing surveys collected by the Brazilian Statistical Agency (IBGE). This data allows us to measure different types of material costs, labor costs, capital depreciation and capital maintenance costs, taxes, and sales for the average Brazilian manufacturing firm. We use this information to construct measures of v_I and f_I equivalent to the ones in our model.

This approach leads to the following estimates for the key variables and moments: $v_I = 0.385$, $f_I = 0.580$, $\alpha = 0.56$, $\theta = 0.65$, $\beta = 0.29$, $s_I^E = 0.20$, and $N = 11$. In this calibration, the estimated values for (R, γ) are $R = 1.05$ and $\gamma = 0.07$. The values for (C, F) depend on the size set for the firm y_I. Recall that this last choice does not change the estimated effects from the model and key values of the steady state. We use these values for $(v_I, f_I, \alpha, \theta, \beta, s_I^E, N)$ to simulate the firm's responses to shocks and counterfactuals using the closed-form expressions explained above. When analyzing the case with variable labor, we assume that there is a two-period delay (two semesters or one year) in the ability of the firm to internally reallocate its labor after the start of the shock (the firm can then reallocate labor without frictions each period).

Finally, when simulating the response to a shock over time, we infer the values for δ_t from the empirical estimates for the direct effect of shocks in the data (Table 2). The firm-level shocks we analyze in our results are average exchange rate shocks across export destinations and these

empirical results capture the direct effects from these same exchange rate shocks. Given the calibrated parameters, the estimated direct effect in each semester allows us to uniquely determine the values for δ_t over time, i.e., there is a single sequence of shocks that exactly matches the data. In this analysis, we use the expression above for $Direct_i^t$ and incorporate the component of $FinMultiplier_i^t$ in the empirical direct effect. To see this, note that we can recover δ_0 using the expression for $Direct_i^0$ (no financial multiplier in the initial period). We can then use δ_0 to determine and remove the financial multiplier from the estimated effect at $t = 1$. This allows us to estimate δ_1, determine the financial multiplier at $t = 2$, and so on. The values obtained for δ_t capture the response of C_i^t over time to an initial appreciation or depreciation of the exchange rate in market i. We use these values for δ_t to simulate firm spillover effects and total effects from firm-level shocks to these exchange rates using the calibrated model. We do not use any information from our empirical estimates for the spillover effects and the total effects when making these simulations. Intuitively, the predicted values for spillover and total effects capture the implications of the model given the direct effects we observe empirically.

Model Extension: Variable Labor

In the Internet Appendix, we show how our results from the simulated model remain similar as we incorporate the possibility of some portion of the firm's labor to be variable input as m. We model this possibility using a production function $Q_i^t = A_i^t(K_i^t)^{\tilde{\alpha}}(L_i^t)^{\widetilde{\beta_1}}(VL_i^t)^{\widetilde{\beta_2}}(m_i^t)^{\tilde{\theta}}$, where VL_i^t is the variable labor and L_i^t is the fixed labor (the other assumptions remain the same). We show that this case can be analyzed in a similar way to the previous one by considering a total variable cost that combines both m and VL. Relative to the previous analysis, there is now a reduction in operating leverage, but there is also a stronger response of the variable inputs (as the cut in these inputs has a stronger effect on sales).

Table 1
Summary Statistics

This table presents summary statistics. Panel A shows summary statistics on the main sample used in the analysis. The unit of observation is a firm × product × destination × semester. The sample covers all instances where the firm × product × destination has some export transaction in the previous semester and where there is exchange rate data for the destination country. The sample period is from the second semester of 1996 to the end of 2005 (see Section 2.1). *FExpGrowth* (t) is the difference in firm-level exports between semesters t and t-1, scaled by the average value of the firm-level exports across these two periods. *ProdExpGrowth* (t) is a product-level measure of export growth constructed in the same way using the value of exports at the firm × product × destination level (product is a six-digit harmonized product code). *ProdExpGrowth* $(t+k)$ is the firm × product × destination-level export growth measure from semester t-1 to $t+k$. *FERShock* $(t+k)$ is the firm-specific exchange rate shock from semester t-1 to $t+k$, defined as the weighted average of the log changes in exchange rates across destinations, where the weights are the export shares in the previous semester. *Market ERShock* (t) is the exchange rate shock to the market (product × destination), and *Other ERShock* (t) is the exchange rate shock to the other markets from the same firm (see Sections 2.2 and 2.3). *CloseShock* (t) and *DistantShock* (t) decompose *FERShock* (t) into exchange rate shocks to close products and to distant products, respectively (see Section X). Close and distant products are defined as products in the same harmonized 6-, 4-, or 2-digit product code. Panel B shows summary statistics for firm characteristics in the sample from Panel A. The unit of observation here is a firm × semester and firm characteristics are measured in semester t-1. *Firm Employment* is the total number of workers in the firm. *High Skilled Employment Share* is the share of workers that have at least high-school education. *Number of Plants* is the number of operating (active) plants. Panel C shows the share of the manufacturing industry in the sample using three measures based on the exporter's main industry: the share of the number of observations, the share of the aggregate export volume in the sample (annual average), and the share of the aggregate number of export transactions (annual average).

Panel A: Main Sample

	Nobs	Mean	Median	SD
ProdExpGrowth (t)	2,492,806	-0.878	-1.422	1.250
ProdExpGrowth $(t+1)$	2,492,806	-0.974	-1.997	1.248
ProdExpGrowth $(t+2)$	2,492,806	-1.052	-2.000	1.255
FExpGrowth (t)	2,492,806	-0.131	0.015	0.816
FERShock (t)	2,492,806	0.004	-0.005	0.144
FERShock $(t+1)$	2,492,806	0.000	-0.021	0.199
Market ERShock (t)	2,492,806	0.003	-0.005	0.143
Other ERShock (t)	2,421,814	-0.001	-0.014	0.160
CloseShock (t) *(6-digit code)*	2,492,806	0.002	0.000	0.064
CloseShock (t) *(4-digit code)*	2,492,806	0.003	0.000	0.078
CloseShock (t) *(2-digit code)*	2,492,806	0.003	0.000	0.099
DistantShock (t) *(6-digit code)*	2,492,806	0.002	0.000	0.120
DistantShock (t) *(4-digit code)*	2,492,806	0.001	0.000	0.110
DistantShock (t) *(2-digit code)*	2,492,806	0.001	0.000	0.091

Panel B: Firm Characteristics

	Nobs	Mean	Median	SD
Firm Employment $(t-1)$	200,202	298	53	2,094
High Skilled Employment Share $(t-1)$	200,202	0.460	0.423	0.309
Number of Plants $(t-1)$	200,202	2.85	1.00	48.29
Number of Export Destinations $(t-1)$	200,202	4.36	2.00	6.74
Number of Export Products $(t-1)$	200,202	5.50	2.00	18.68

Panel C: Role of Manufacturing Industry

Manufacturing Share of Nobs	Manufacturing Share of Export Volume	Manufacturing Share of Number of Transactions
0.78	0.74	0.75

Table 2
Firms' Responses to Export Demand Conditions: Direct and Firm Spillover Effects

This table analyzes how firms' exports in an existing market (product × destination) respond to shocks to demand conditions in both that same market and other markets. The unit of observation is a firm × product × destination × semester. We restrict our main sample (Table 1) to observations without missing values from all outcome variables. *ProdExpGrowth* $(t+k)$ is the difference in firm × product × destination exports between semesters $t+k$ and $t-1$, scaled by the average value of these exports across the two periods. *ProdExpGrowth* $(t+1,\ t+2)$ is the simple average of *ProdExpGrowth* $(t+1)$ and *ProdExpGrowth* $(t+2)$. *ProdExpGrowth* $(t+2,\ t+3)$ and *ProdExpGrowth* $(t+4,\ t+5)$ are defined analogously. *FERShock* (t) is the firm-specific exchange rate shock from semester $t-1$ to t, defined as the weighted average of the log changes in exchange rates across destinations, where the weights are the export shares in the previous semester. *Market ER Shock* (t) captures direct effects from *FERShock* (t) and is the exchange rate shock to the market (product × destination) being analyzed. *Other ER Shock* (t) captures firm spillover effects from *FERShock* (t) and is the (average) exchange rate shock to the other markets from the same firm. Columns (1), (3), and (5) show results based on the estimation of equation (1). Columns (2), (4), and (6) show the total effect from shocks to export demand conditions and are based on a similar specification where *Market ER Shock* and *Other ER Shock* are replaced with *Firm ER Shock*. The sample only includes observations where the firm × product × destination has some export transaction in the previous semester. To capture firm-level effects, all regressions are weighted using the share of firms' exports in each product × destination in semester $t-1$. Standard errors are heteroskedasticity robust and two-way clustered at the firm and product × destination levels. We report the respective t-statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

	ProdExpGrowth (t, t+1)		ProdExpGrowth (t+2, t+3)		ProdExpGrowth (t+4, t+5)	
	(1)	(2)	(3)	(4)	(5)	(6)
Market ER Shock (t)	0.6112***		0.2003***		0.0155	
	(21.39)		(6.41)		(0.45)	
Other ER Shock (t)	0.1421***		0.2020***		0.2182***	
	(5.16)		(7.02)		(6.97)	
FER Shock (t)		0.7555***		0.4201***		0.2576***
		(19.97)		(10.60)		(6.21)
Observations	1,864,251	1,864,251	1,864,251	1,864,251	1,864,251	1,864,251
R^2	0.01	0.01	0.01	0.01	0.01	0.01
Time FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 3
Temporary Shocks to Export Demand Conditions

This table shows the construction of temporary shocks to firm export demand conditions using firm-specific exchange rates. Panel A shows the immediate responses of firms' total exports to temporary shocks to firm-level exchange rates. The results are based on the estimation of equation (2) using measures of firms' total export growth as the outcome variable. The unit of observation is a firm × product × destination × semester. *FExpGrowth* (t) is the difference in firm-level exports between semesters t-1 and t, scaled by the average value of the firm-level exports across these two periods. *FERShock* (t) is the firm-specific exchange rate shock from semester t-1 to t, defined as the weighted average of the log changes in exchange rates across destinations, where the weights are the firm's export shares in the previous semester. The sample only includes observations where the firm × product × destination has some export transaction in the previous semester. Model 1 controls for *FERShock* (t+1), the firm-specific exchange rate shock from semester t-1 to t+1. Model 2 uses a third-degree polynomial function of *FERShock* (t+1) to construct the control variables. To capture firm-level effects, all regressions are weighted using the share of firms' exports in each product × destination in semester t-1. Standard errors are heteroskedasticity robust and two-way clustered at the firm and product × destination levels. Panel B checks if temporary shocks to firm-specific exchange rates are correlated with different firm characteristics. Based on firm semi-annual data covering our main sample, we estimate linear regressions predicting different initial firm characteristics (measured in semester t–1) using *FERShock* (t) and controlling for *FERShock* (t+1). Standard errors are heteroskedasticity robust and clustered at the firm level. We report the respective t-statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: Constructing Temporary Shocks

	FExpGrowth (t)	
	(1)	(2)
FERShock (t)	0.4646***	0.5590***
	(6.94)	(8.10)
Observations	2,492,405	2,492,405
R^2	0.01	0.01
Product × Destination × Time FE	Yes	Yes
Controls	Model 1	Model 2

Panel B: Temporary Shocks and Firm Characteristics

	Firm Characteristics - Measured at Semester t - 1				
	Log of Firm Employment	HS Employment Share	Log Number of Plants	Log Number of Destinations	Log Number of Products
	(1)	(2)	(3)	(4)	(5)
FERShock (t)	-0.039	0.013	-0.016	-0.007	0.009
	(-0.82)	(1.50)	(-1.01)	(-0.31)	(0.32)
Observations	200,202	200,202	200,202	200,202	200,202
R^2	0.01	0.01	0.01	0.01	0.01
Industry × Time FE	Yes	Yes	Yes	Yes	Yes
Controls	Model 1	Model 1	Model 1	Model 1	Model 1

Table 4
Firm Spillover Effects from Temporary Shocks to Export Markets

This table analyzes firm spillover effects from temporary shocks to export demand conditions. The analysis captures how temporary shocks to export markets from a firm during semester t shape the firm's exports to other markets over subsequent semesters. The results are based on the estimation of equation (2). The unit of observation is a firm × product × destination × semester. *ProdExpGrowth* $(t+k)$ is the difference in firm × product × destination exports between semesters $t+k$ and $t-1$, scaled by the average value of these exports across the two periods. *FERShock* (t) is the firm-specific exchange rate shock from semester $t-1$ to t, defined as the weighted average of the log changes in exchange rates across destinations, where the weights are the export shares in the previous semester. The sample only includes observations where the firm × product × destination has some export transaction in the previous semester. Model 1 controls for *FERShock* $(t+1)$, the firm-specific exchange rate shock from semester $t-1$ to $t+1$. Model 2 uses a third-degree polynomial function of *FERShock* $(t+1)$ to construct the control variables. To capture firm-level effects, all regressions are weighted using the share of firms' exports in each product × destination in semester $t-1$. Standard errors are heteroskedasticity robust and two-way clustered at the firm and product × destination levels. We report the respective t-statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

	ProdExpGrowth (t)		ProdExpGrowth (t+1)		ProdExpGrowth (t+2)	
	(1)	(2)	(3)	(4)	(5)	(6)
FERShock (t)	-0.0729	-0.0194	0.1645***	0.2422***	0.2612***	0.3253***
	(-1.30)	(-0.34)	(3.48)	(4.74)	(5.67)	(6.45)
Observations	2,492,405	2,492,405	2,492,405	2,492,405	2,492,405	2,492,405
R^2	0.01	0.01	0.01	0.01	0.01	0.01
Product × Destination × Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2

Table 5
Firm Spillover Effects: The Role of Economic Links

This table provides additional evidence on the potential role of economic links in driving the previous firm spillover effects. In Panel A, we separately estimate the effect of temporary shocks to other export markets with close or distant products. The results are based on the estimation of equation (3). *Close Shock* (t) and *Distant Shock* (t) decompose *FERShock* (t) into shocks that originate in markets with close (similar) or distant products. We use three different definitions for close or similar products: products within the same 2-, 4-, or 6-digit harmonized product code. In addition to showing the estimated coefficients for *Close Shock* (t) and *Distant Shock* (t), we also report the estimated difference between these two coefficients. In Panel B, we analyze spillover effects within a firm and product. We estimate a specification analogous to equation (2) where we replace *FirmERShock* (t + k) with *ProdERShock* (t + k) for k = 0 ,1. *ProdERShock* (t + k) is the weighted average of log changes in exchange rates across export destinations for the firm's product between semester t -1 and t + k (using firm × product export shares in semester t - 1 as weights). We estimate specifications with and without *FirmERShock* (t) as a control. When this control is included, the temporary shock to the product does not predict firm balance-sheet effects and only incorporates economic spillover effects within the firm. *ProdExpGrowth* (t + 1, t + 2) is the simple average of *ProdExpGrowth* (t + 1) and *ProdExpGrowth* (t + 2). To capture firm-level effects, all regressions are weighted using the share of firms' exports in each product × destination in semester t-1. Standard errors are heteroskedasticity robust and two-way clustered at the firm and product × destination levels. We report the respective t statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: Export Demand Shocks to Close and Distant Products

Close Product Definition:	Same 6-digit Product Code		Same 4-digit Product Code		Same 2-digit Product Code	
Outcome Variable:	ProdExpGrowth (t+1)	ProdExpGrowth (t+2)	ProdExpGrowth (t+1)	ProdExpGrowth (t+2)	ProdExpGrowth (t+1)	ProdExpGrowth (t+2)
	(1)	(2)	(3)	(4)	(5)	(6)
Close Shock (t)	0.1327***	0.2345***	0.1408***	0.2405***	0.1532***	0.2508***
	(2.80)	(5.07)	(2.98)	(5.21)	(3.24)	(5.45)
Distant Shock (t)	0.3038***	0.3564***	0.3203***	0.3683***	0.3144***	0.3732***
	(5.24)	(6.43)	(5.30)	(6.40)	(4.73)	(5.79)
Observations	2,492,405	2,492,405	2,492,405	2,492,405	2,492,405	2,492,405
R^2	0.00	0.00	0.00	0.00	0.00	0.00
Close Shock (t) - *Distant Shock* (t)	-0.1711***	-0.1218***	-0.1794***	-0.1277***	-0.1612***	-0.1224***
	(-4.77)	(-3.58)	(-4.74)	(-3.57)	(-3.54)	(-2.84)
Product × Destination × Time FE	Yes	Yes	Yes	Yes	Yes	Yes
CloseFERShock (t+1) Control	Yes	Yes	Yes	Yes	Yes	Yes
DistantFERShock (t+1) Control	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: Positive Spillover Effects and Firm Balance Sheet Conditions						
Product Shock Definition:	6-digit Product Code Shock		4-digit Product Code Shock		2-digit Product Code Shock	
Outcome Variable:	ProdExpGrowth (t+1, t+2)	ProdExpGrowth (t+1, t+2)	ProdExpGrowth (t+1, t+2)	ProdExpGrowth (t+1, t+2)	ProdExpGrowth (t+1, t+2)	ProdExpGrowth (t+1, t+2)
	(1)	(2)	(3)	(4)	(5)	(6)
ProdERShock (*t*)	0.2349***	-0.1866***	0.2348***	-0.1769***	0.2336***	-0.2254***
	(5.03)	(-3.22)	(5.23)	(-2.87)	(5.46)	(-3.11)
Observations	2,492,405	2,492,405	2,492,405	2,492,405	2,492,405	2,492,405
R^2	0.00	0.00	0.00	0.00	0.00	0.00
Product × Destination × Time FE	Yes	Yes	Yes	Yes	Yes	Yes
FERShock (*t*) Control	No	Yes	No	Yes	No	Yes
ProdERShock (*t*+1) Control	Yes	Yes	Yes	Yes	Yes	Yes

Table 6
Firm Spillover Effects: The Role of Operating Leverage

This table analyzes the link between firm spillover effects and the importance of fixed operating costs (higher wages at the firm level). We separately estimate the effect of temporary exchange rate shocks for each tercile of *Firm Wage* $(t - 1)$, the average wage of the firm in semester $t - 1$. In column (1), we interact the two variables capturing exchange rate shocks (*FERShock* (t) and *FERShock* $(t + 1)$) in equation (2) with *High Wage*, *Middle Wage*, and *Low Wage*, and also include these firm wage variables without interactions. *High Wage, Medium Wage,* and *Low Wage* are indicators for firms in the top, middle, and bottom terciles of *Firm Wage* $(t - 1)$ in a given semester. In columns (2) to (4), we estimate differential effects by ommiting *Low Wage* and including the two exchange rate shock variables as controls (without interactions). In columns (3) and (4), we include additional controls: the interactions between the exchange rate shock variables and indicators for the top two terciles of firm size (column (3)) and indicators for the top two terciles of both firm size and age (column (4)). *ProdExpGrowth (t+1, t+2)* is the simple average of *ProdExpGrowth (t+1)* and *ProdExpGrowth (t+2)*. To capture firm-level effects, all regressions are weighted using the share of firms' exports in each product × destination in semester *t-1* Standard errors are heteroskedasticity robust and two-way clustered at the firm and product × destination levels. We report the respective t-statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

	ProdExpGrowth (t+1, t+2)			
	(1)	(2)	(3)	(4)
FERShock (t) × *High Wage*	0.2419***	0.1153***	0.0947**	0.0949**
	(4.93)	(2.77)	(2.25)	(2.24)
FERShock (t) × *Medium Wage*	0.1685***	0.0408	0.0185	0.0195
	(3.74)	(1.14)	(0.51)	(0.54)
FERShock (t) × *Low Wage*	0.1358***			
	(2.92)			
Observations	2,356,539	2,356,539	2,356,539	2,356,539
R^2	0.01	0.01	0.04	0.04
Product × Destination × Time FE	Yes	Yes	Yes	Yes
FERShock (t) Control		Yes	Yes	Yes
FERShock $(t+1)$ Controls	Yes	Yes	Yes	Yes
Size Controls			Yes	Yes
Age Controls				Yes

Table 7
Firm Spillover Effects: Longer Time Horizons

This table analyzes firm spillover effects from temporary shocks to export conditions using longer time horizons (up to three years). We estimate the same specifications as in Table 4 using alternative outcome variables that capture longer-term responses. *ProdExpGrowth* ($t+k$) is the difference in firm × product × destination exports between semesters $t+k$ and $t-1$, scaled by the average value of these exports across the two periods. *ProdExpGrowth* ($t+1$, $t+2$) is the simple average of *ProdExpGrowth* ($t+1$) and *ProdExpGrowth* ($t+2$). *ProdExpGrowth* ($t+3$, $t+5$) is the simple average of *ProdExpGrowth* ($t+3$), *ProdExpGrowth* ($t+4$), and *ProdExpGrowth* ($t+5$). All other variables and controls are defined in the same way as in Table 4. The sample period is now from the second semester of 1996 to the first semester of 2004. To capture firm-level effects, all regressions are weighted using the share of firms' exports in each product × destination in semester $t-1$. Standard errors are heteroskedasticity robust and two-way clustered at the firm and product × destination levels. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

	ProdExpGrowth (t)		ProdExpGrowth (t+1, t+2)		ProdExpGrowth (t+3, t+5)	
	(1)	(2)	(3)	(4)	(5)	(6)
FERShock (t)	-0.0431	0.0301	0.2377***	0.3298***	0.2780***	0.3311***
	(-0.76)	(0.51)	(5.78)	(7.29)	(6.17)	(6.83)
Observations	1,923,169	1,923,169	1,923,169	1,923,169	1,923,169	1,923,169
R^2	0.01	0.01	0.01	0.01	0.01	0.01
Product × Destination × Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2

Table 8
Results Using Longer Time Horizons: The Role of Economic Links

This table analyzes the role of economic links in driving firm spillover effects using longer time horizons. We estimate the same specifications as in Table 5 using alternative outcome variables. *ProdExpGrowth* ($t+k$) is the difference in firm × product × destination exports between semesters $t+k$ and $t-1$, scaled by the average value of these exports across the two periods. *ProdExpGrowth* ($t+1$, $t+2$) is the simple average of *ProdExpGrowth* ($t+1$) and *ProdExpGrowth* ($t+2$). *ProdExpGrowth* ($t+3$, $t+5$) is the simple average of *ProdExpGrowth* ($t+3$), *ProdExpGrowth* ($t+4$), and *ProdExpGrowth* ($t+5$). All other variables and controls are defined in the same way as in Table 5. The sample period is now from the second semester of 1996 to the first semester of 2004. To capture firm-level effects, all regressions are weighted using the share of firms' exports in each product × destination in semester $t-1$. Standa errors are heteroskedasticity robust and two-way clustered at the firm and product × destination level. We report the respective t-statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: Exchange Rate Shocks to Close and Distant Products

	Firm-Product Exchange Rate Shock (6-digit)		Firm-Product Exchange Rate Shock (4-digit)		Firm-Product Exchange Rate Shock (2-digit)	
	ProdExpGrowth (t+1, t+2)	ProdExpGrowth (t+3, t+5)	ProdExpGrowth (t+1, t+2)	ProdExpGrowth (t+3, t+5)	ProdExpGrowth (t+1, t+2)	ProdExpGrowth (t+3, t+5)
	(1)	(2)	(3)	(4)	(5)	(6)
Close Shock (t)	0.1946***	0.2431***	0.2031***	0.2487***	0.2191***	0.2625***
	(4.69)	(5.33)	(4.93)	(5.50)	(5.33)	(5.81)
Distant Shock (t)	0.3056***	0.3410***	0.3214***	0.3526***	0.3280***	0.3463***
	(6.14)	(6.91)	(6.24)	(6.89)	(5.77)	(6.23)
Observations	1,923,169	1,923,169	1,923,169	1,923,169	1,923,169	1,923,169
R^2	0.00	0.00	0.00	0.00	0.00	0.00
Close Shock (t) - *Distant Shock* (t	-0.1111***	-0.0979***	-0.1184***	-0.1039***	-0.1089***	-0.0838**
	(-3.70)	(-3.55)	(-3.75)	(-3.60)	(-2.87)	(-2.45)
Product × Destination × Time FE	Yes	Yes	Yes	Yes	Yes	Yes
CloseFERShock ($t+1$) Control	Yes	Yes	Yes	Yes	Yes	Yes
DistantFERShock ($t+1$) Control	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: Positive Spillover Effects and Firm Balance Sheet Conditions						
	Firm-Product Exchange Rate Shock (6-digit)		Firm-Product Exchange Rate Shock (4-digit)		Firm-Product Exchange Rate Shock (2-digit)	
	ProdExpGrowth (t+3, t+5)	ProdExpGrowth (t+3, t+5)	ProdExpGrowth (t+3, t+5)	ProdExpGrowth (t+3, t+5)	ProdExpGrowth (t+3, t+5)	ProdExpGrowth (t+3, t+5)
	(1)	(2)	(3)	(4)	(5)	(6)
ProdERShock (*t*)	0.2686***	-0.3021***	0.2857***	-0.2414***	0.2999***	-0.2467***
	(5.29)	(-4.72)	(5.77)	(-3.54)	(6.31)	(-3.06)
Observations	1,923,169	1,923,169	1,923,169	1,923,169	1,923,169	1,923,169
R^2	0.00	0.00	0.00	0.00	0.00	0.00
Product × Destination × Time FE	Yes	Yes	Yes	Yes	Yes	Yes
FERShock (*t*) Control	No	Yes	No	Yes	No	Yes
ProdERShock (*t*+1) Control	Yes	Yes	Yes	Yes	Yes	Yes

Table 9
Results Using Longer Time Horizons: The Role of Operating Leverage

This table analyzes the link between firm spillover effects and fixed operating costs (higher firm wages) using longer time horizons. We estimate the same specifications as in Table 6 using alternative outcome variables. *ProdExpGrowth1 (t+k)* is the difference in firm × product × destination exports between semesters $t+k$ and $t-1$, scaled by the average value of these exports across the two periods. *ProdExpGrowth (t+1, t+2)* is the simple average of *ProdExpGrowth (t+1)* and *ProdExpGrowth (t+2)*. *ProdExpGrowth (t+3, t+5)* is the simple average of *ProdExpGrowth (t+3)*, *ProdExpGrowth (t+4)*, and *ProdExpGrowth (t+5)*. All other variables and controls are defined in the same way as in Table 6. The sample period is now from the second semester of 1996 to the first semester of 2004. To capture firm-level effects, all regressions are weighted using the share of firms' exports in each product × destination in semester $t-1$. Standard errors are heteroskedasticity robust and two-way clustered at the firm and product × destination level. We report the respective t-statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

	ProdExpGrowth (t+1, t+2)				ProdExpGrowth (t+3, t+5)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
FERShock (t) × High Wage	0.2522***	0.0948**	0.0750*	0.0739*	0.2900***	0.1088***	0.1010**	0.0998**
	(5.10)	(2.26)	(1.76)	(1.72)	(5.64)	(2.76)	(2.54)	(2.47)
FERShock (t) × Medium Wage	0.1827***	0.0241	0.0045	0.0048	0.2468***	0.0643*	0.0451	0.0465
	(4.03)	(0.67)	(0.12)	(0.13)	(5.15)	(1.88)	(1.31)	(1.34)
FERShock (t) × Low Wage	0.1676***				0.1914***			
	(3.55)				(3.76)			
Observations	1,818,140	1,818,140	1,818,140	1,818,140	1,818,140	1,818,140	1,818,140	1,818,140
R^2	0.01	0.01	0.04	0.04	0.01	0.01	0.04	0.05
Product × Destination × Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FERShock (t) Control		Yes	Yes	Yes		Yes	Yes	Yes
FERShock (t+1) Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Size Controls			Yes	Yes			Yes	Yes
Age Controls				Yes				Yes

Table 10
Financial Multiplier Effect: IV Estimates

This table shows empirical estimates for the magnitude of the financial multiplier effect we propose. The results are based on the estimation of equation (4) using an IV approach, where the first stage is given by the specifications in Table 4. Specifically, we use *FERShock* (*t*) as an instrument for *FExpGrowth* (*t*) while controlling for *FERShock* (*t* +1) (Model 1) or for a third-degree polynomial function of *FERShock (t+1)* (Model 2). In columns (1) to (4), we analyze the same outcome variables and sample as in Table 4. In columns (5) to (8), we use the longer time horizon sample from Table 7. *FExpGrowth* (*t*) is the difference in firm-level exports between semesters *t* and *t*-1, scaled by the average value of these firm-level exports across the two periods. All other variables and controls are defined in the same way as in Tables 4 and 7. To capture firm-level effects, all regressions are weighted using the share of firms' exports in each product × destination in semester *t*-1. Standard errors are heteroskedasticity robust and two-way clustered at the firm and product × destination level. We report the respective t-statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

	Main Sample				Longer Horizon Sample			
	ProdExpGrowth (t+1)		ProdExpGrowth (t+2)		ProdExpGrowth (t+1, t+2)		ProdExpGrowth (t+3, t+5)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
FExpGrowth (*t*)	0.3541***	0.4332***	0.5623***	0.5819***	0.5219***	0.5860***	0.6103***	0.5883***
	(3.52)	(4.69)	(5.07)	(5.99)	(5.22)	(6.58)	(5.65)	(6.56)
Observations	2,492,405	2,492,405	2,492,405	2,492,405	1,923,169	1,923,169	1,923,169	1,923,169
Product × Destination × Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2

Table 11
Financial Multiplier and Firm Spillover Effects: Model Simulations

This table presents the simulated effects from the structural calibrated model and compares these effects to their empirical counterparts (see Section 4 for more details). Panels A and B report the simulated values and the IV estimates (Table 10) for the financial multiplier effect we propose. Panels C to E show the simulated values and empirical estimates for the firm spillover, direct, and total effects of shocks to export demand conditions analyzed in Table 2. Spillover effects capture the impact of demand shocks in others markets on a given export market (product × destination). Direct effects reflect the impact of demand shocks in the market itself. Total effects represent the sum of spillover and direct effects. Approach 1 analyzes a scenario in which firms cannot reallocate internal labor across markets, while Approach 2 considers a scenario in which such reallocation is possible and frictionless. In each analysis, the shock is initiated during semester t. The effect from semester t + k to t + h is the average effect across all the semesters in this period.

Panel A: Financial Multiplier - Shorter Horizon

	Model	IV Estimates
	(1)	(2)
Average Effect (t+1, t+2)	0.47	0.48
Elasticity (t+1)	0.44	0.39
Elasticity (t+2)	0.50	0.57

Panel B: Financial Multiplier - Longer Horizon

	Model	IV Estimates
	(1)	(2)
Average Effect (t+1, t+5)	0.56	0.58
First Year (t+1, t+2)	0.47	0.55
Subsequent Effect (t+3, t+5)	0.63	0.60

Panel C: Spillover Effects

	Model - Spillover		Data - Spillover
	Approach 1	Approach 2	
	(1)	(2)	(3)
Immediate Effect (t)	-0.09	-0.09	0.10
Average Effect (t+1 to t+5)	0.21	0.18	0.21
First Year (t+1, t+2)	0.10	0.09	0.19
Subsequent Effect (t+3 to t+5)	0.28	0.24	0.21

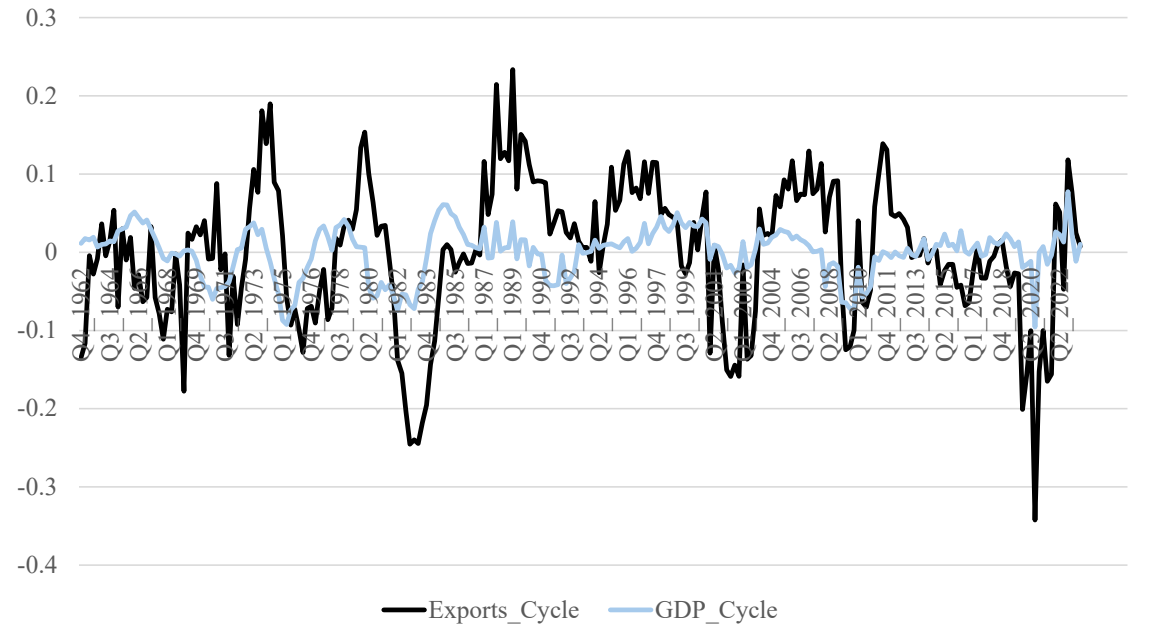
Panel D: Total Firm Effects			
	Model - Total Effect		Data - Total Effect
	Approach 1	Approach 2	
	(1)	(2)	(3)
Immediate Effect (t)	0.63	0.63	0.81
Average Effect (t+1 to t+5)	0.40	0.37	0.39
First Year (t+1, t+2)	0.48	0.48	0.58
Subsequent Effect (t+3 to t+5)	0.34	0.29	0.27

Panel E: Direct Effects and Unconstrained Responses			
	Model - Unconstrained Response		Data - Direct Effect
	Approach 1	Approach 2	
	(1)	(2)	(3)
Immediate Effect (t)	0.72	0.72	0.71
Average Effect (t+1 to t+5)	0.17	0.16	0.19
First Year (t+1, t+2)	0.37	0.35	0.38
Subsequent Effect (t+3 to t+5)	0.03	0.03	0.06

Figure 1
Export Volatility: Broad Patterns

This figure shows broad patterns for the volatility of exports and GDP in the United States and Brazil. We use quarterly data from the OECD on the real value of exports and GDP in each country, which is available between 1960-2023 for the U.S. and between 1996-2023 for Brazil. To construct the cycle for each time series (remove the trend), we use log values and follow the approach in Hamilton (2018). In each case, we estimate the cycle as the residual of a linear regression predicting $y(t)$ using $y(t-8)$, $y(t-9)$, $y(t-10)$, $y(t-11)$, and a constant. We have found similar patterns using alternative approaches to capture cycles.

Panel A: Exports and GDP Cycles - United States



Panel B: Exports and GDP Cycles - Brazil

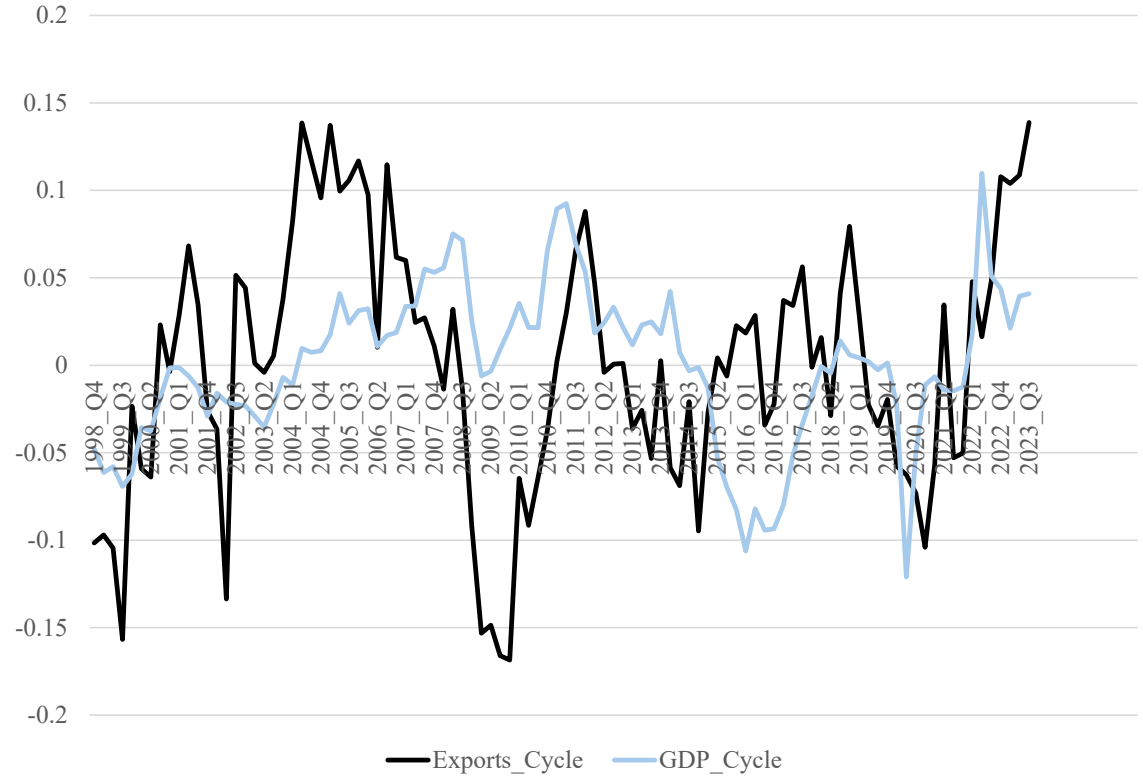


Figure 2
Firms' Responses to Export Demand Conditions: Direct and Firm Spillover Effects

This figure presents the direct, firm spillover, and total effects estimated in Table 2 separately for each semester (from semester *t* to semester *t+5*). The results are based on the estimation of the same specifications as in Table 2 using different outcome variables. For each semester *t* + k, we show the estimates using *ProdExpGrowth* (*t*+k) as the outcome variable. *ProdExpGrowth (t+k)* is the difference in firm × product × destination exports between semesters *t*+k and *t*-1, scaled by the average value of these product exports across the two periods.

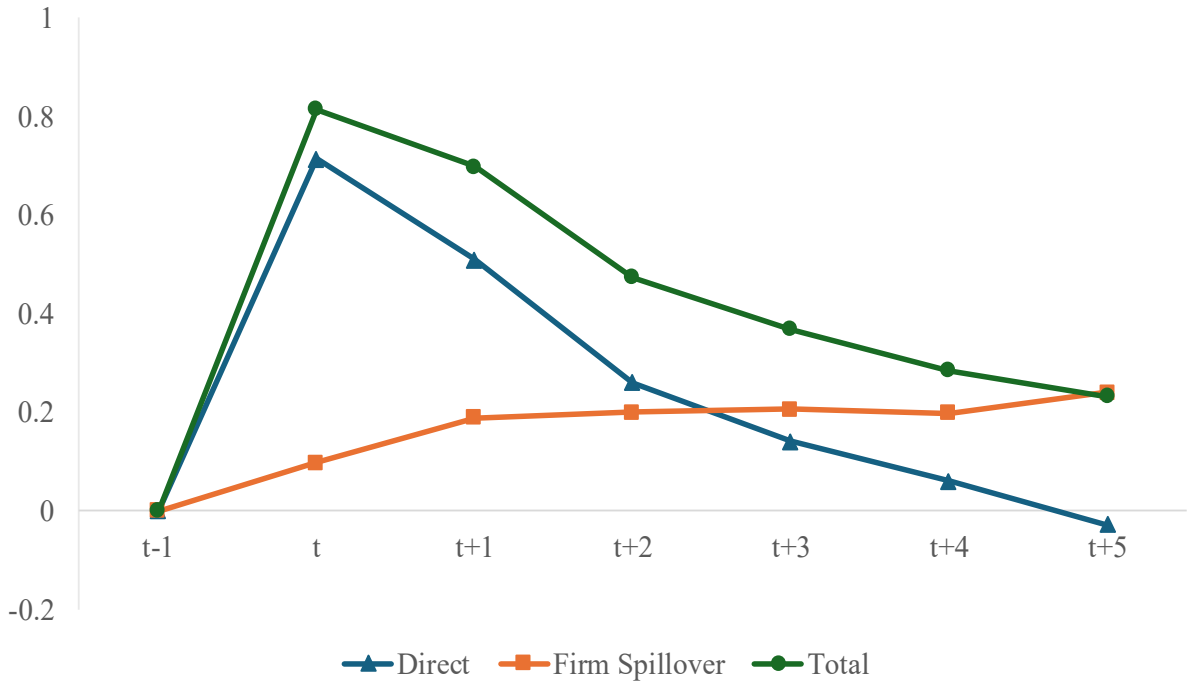


Figure 3
Firm Spillover Effects from Temporary Shocks: Results by Semester

This figure presents the reduced-form estimates in Table 7 separately for each semester (from semester t to $t+5$). The results are based on the estimation of the same specifications as in Table 7 using different outcome variables. For each semester $t+k$, we show the estimates using *ProdExpGrowth* $(t+k)$ as the outcome variable. *ProdExpGrowth* $(t+k)$ is the difference in firm × product × destination exports between semesters $t+k$ and $t-1$, scaled by the average value of these product exports across the two periods. In each case, we plot the estimated coefficient of *FERShock* (t). Model 1 controls for *FERShock* $(t+1)$, while Model 2 uses a third-degree polynomial function of *FERShock* $(t+1)$ to construct the control variables. Standard errors are heteroskedasticity robust and two-way clustered at the firm and product × destination levels. Vertical bars represent a 95-percent confidence interval for each point estimate.

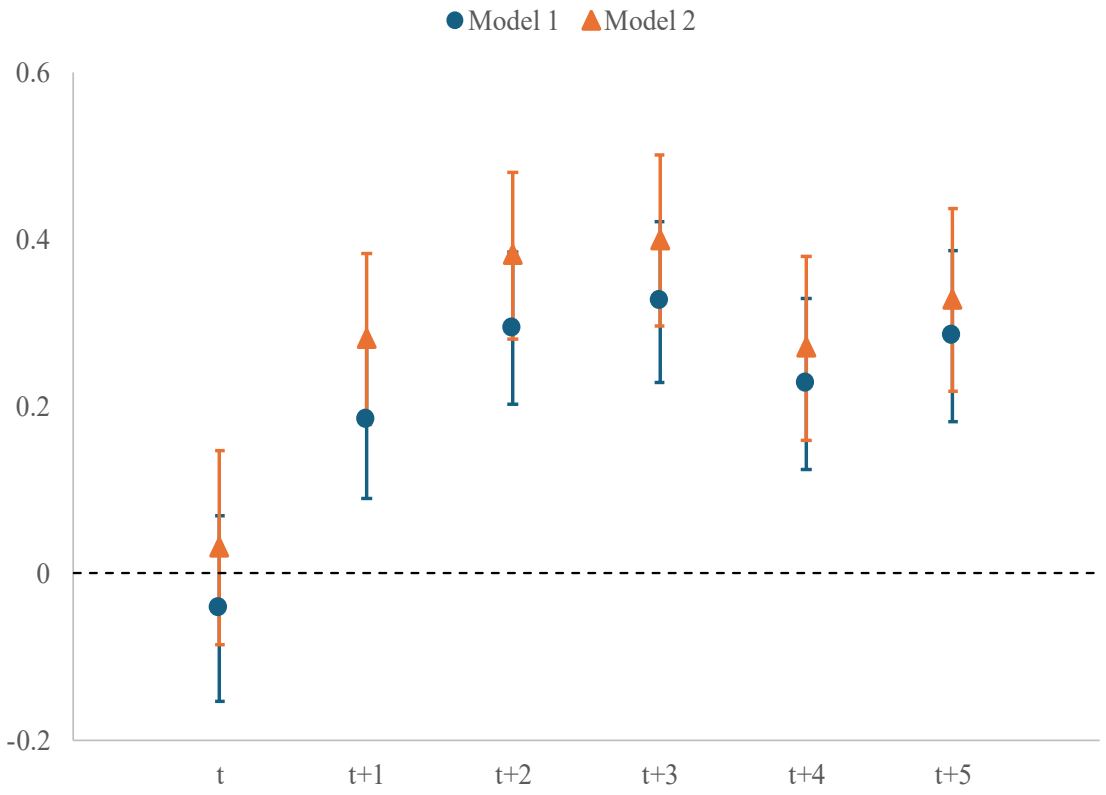


Figure 4
Financial Multiplier: Simulated Effects and IV Estimates by Semester

This figure presents the simulated effects from the model for the financial multiplier we propose and their empirical counterparts. This multiplier captures the percentage change in exports during semester t + k in response to a temporary change of 10 percent in exports during semester t (through a balance-sheet effect). The calculation of the model simulated effects is described in Section 4. The empirical estimates for the financial multiplier are based on the IV approach from Table 10, i.e., the same empirical specification as in Table 10 with different outcome variables. For each semester $t+k$, we show the IV estimates using *ProdExpGrowth (t+k)* as the outcome variable. *ProdExpGrowth (t+k)* is the difference in firm × product × destination exports between semesters $t+k$ and t-1, scaled by the average value of these product exports across the two periods. In each case, we plot the estimated coefficient of *FExpGrowth* (t) (average across estimates from Model 1 and Model 2).

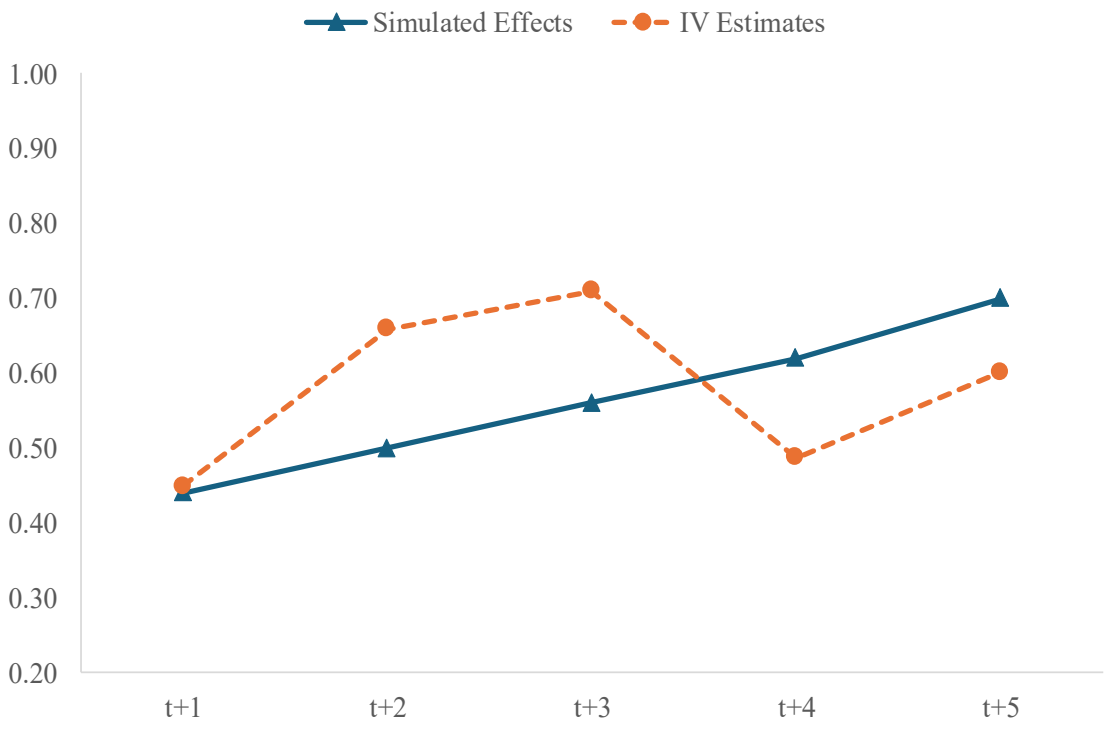
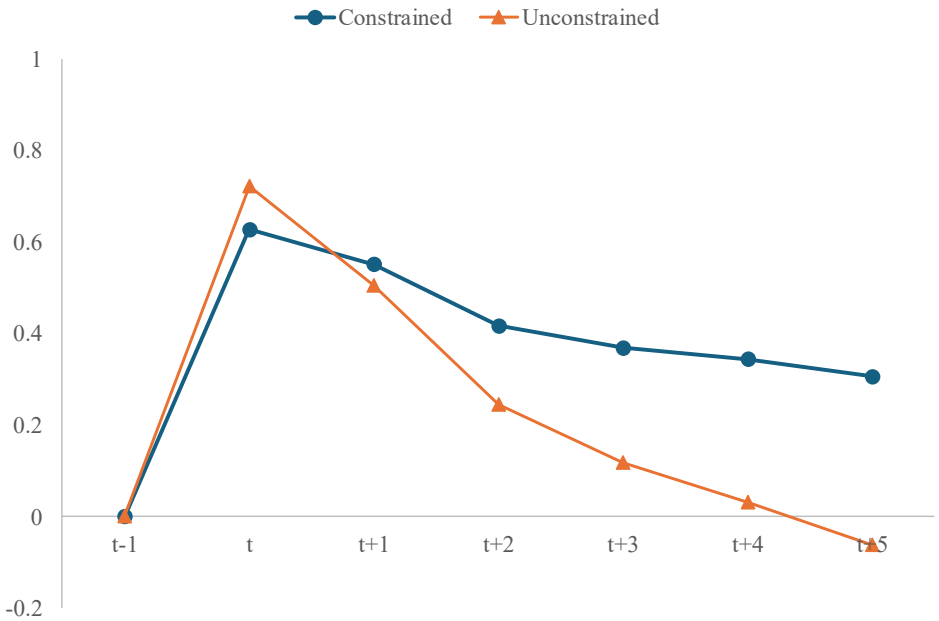


Figure 5
Simulated Counterfactuals: Constrained and Unconstrained Firms

This figure presents the simulated counterfactuals from our calibrated structural model. See Section 4 for more details on how these counterfactuals are calculated. We first consider the predicted response of the firm to export demand shocks in our baseline analysis (with funding constraints). This constrained response captures the total effect of shocks from Table 11, now separately shown for each semester (from semester $t+1$ to $t+5$). Shocks are initiated in semester t. We then consider a counterfactual scenario where the firm does not face working capital funding frictions, i.e., the firm can finance production costs in a frictionless way but face all other frictions in the model. We consider two possibilities when analyzing these two counterfactuals. Panel A analyzes counterfactual scenarios in which firms cannot reallocate internal labor across markets, while Panel B considers scenarios in which such internal labor reallocation is possible (without frictions).

Panel A: No Labor Internal Reallocation



Panel B: Labor Internal Reallocation

