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Abstract

This study finds that even small unexpected supply shocks propagate downstream through production networks and are amplified by firms with short-term financial constraints. The unexpected 2011 increase in the tax on imports purchased with foreign-sourced trade credit is examined using data capturing almost all Turkish supplier-customer links. The identification strategy exploits the heterogeneous impact of the shock on importers. The results indicate that this relatively minor, non-localized shock had a non-trivial economic impact on exposed firms and propagated downstream through affected suppliers. Additional empirical tests, motivated by a simple theory, demonstrate that low-liquidity firms amplified its transmission.

JEL-Codes: F140, F610, G230, L140, E230.

Keywords: production networks, shock transmission, financing constraints, liquidity.

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1 Introduction

Since the seminal work of Acemoglu, Carvalho, Ozdaglar, and Tahbaz-Salehi (2012) on the propagation of idiosyncratic shocks in production networks that lead to aggregate fluctuations in the economy, research has focused on investigating the channels through which such shocks are transmitted. One line of papers provides supporting evidence based on microeconomic (firm-level) data by examining identifiable production-network linkages. To do so, these papers rely on large localized economic shocks perpetrated by natural disasters (e.g., Barrot and Sauvagnat (2016) and Boehm, Flaaen, and Pandalai-Nayar (2019)). The alternative line of research relies on economy-wide shocks and identifies network connections through input-output tables (e.g., Acemoglu, Akcigit, and Kerr (2016)).

Our article differs from the existing literature in a number of dimensions. First, we combine elements of both lines of investigation by examining a macro shock with micro-level data, as we can observe totality of the production network based on firm-level data. As a result, we can examine the economy-wide transmission of a *non-localized* shock, measured with disaggregated data that aren't limited to larger firms with publicly listed securities. Second, we study the propagation of a small unexpected shock, which heterogeneously affects a portion of firms in the production chain. We find that this a priori benign shock not only has a economically non-trivial direct effect but it also gets transmitted downstream through the production network. Third, and most importantly, we study the role of financial constraints in the shock transmission. We focus on liquidity constraints, as the relatively minor yet unexpected regulatory shock that we examine is more likely to affect firms in the shorter run: if companies carry less cash or cash equivalents on their balance sheets, they are more likely to have difficulty to accommodate the effects of the RUSF increase. Our inferences suggest that even relatively small and non-localized shocks propagate through the production networks, especially so when firms are liquidity constrained.

Our paper focuses on a shock that increased the cost of import financing in a heterogeneous manner. In October 2011, the Turkish government unexpectedly doubled the rate of the Resource Utilization Support Fund (RUSF) tax from 3% to 6%.[1] This tax applies only to import transactions backed by international trade financing that is, in effect, a source of credit from non-domestic

[1]For more detail on RUSF, see Section 2.

sources. This regulatory shock had a heterogeneous impact across Turkish importers because the use of international trade credit, which is the subject to the increased tax, differed across firms. Since the increase in the RUSF import duty was unexpected, an adjustment to other sources of financing may not have been possible in the short run. For similar reasons, replacing imported inputs with those sourced domestically is unlikely to have taken place immediately for most firms. Consequently, we examine the most plausible factor that could have delayed firms' reaction to the RUSF increase: whether their pre-shock financial liquidity played a role in the transmission or absorption of the shock.

Our analysis proceeds as follows. First, we empirically investigate the extent to which the input-cost shock affected the importers that were directly exposed to the RUSF tax prior to its increase. Second, we examine whether the shock was transmitted to the upstream and downstream firms in the production network. Since our data allow us to observe the quasi-totality of the supplier-buyer pairs in the economy, we are able to study the propagation of this cost-shock in the entire production network. Third, we investigate the role of short-term financial constraints (referred to as liquidity constraints henceforth) in the transmission of the RUSF shock throughout the economy. To do so, we provide a simple partial equilibrium model that elicits the role of liquidity constraints in the shock's transmission. We extend an otherwise standard model (e.g., Halpern, Koren, and Szeidl (2015)) by allowing firms to choose between paying for imports immediately or delaying payment by using international trade credit. The model presents a simple, yet useful, setting for understanding the propagation of an input cost-shock, such as the increase in the RUSF tax, in a production network. Importantly, it also allows us to illustrate how liquidity constraints affect this propagation, something which we test empirically.[2]

Our results can be summarized as follows. First, we find that firms with greater direct exposure to the RUSF tax prior to its increase experience a decline in sales relative to firms with lesser or no exposure to the shock. The exposed-firms decrease their reliance on imported inputs and add new domestic suppliers, suggesting that the tax increase induces an input reallocation towards domestic sellers. This finding suggests that, for the highly-exposed firms, the *permanent* input-cost increase, which is due to the doubling of the RUSF tax rate, is higher than the costs of switching to domestic

[2] Different from existing literature (e.g. Chaney (2016)), our model focuses on liquidity for financing importer's working capital needs.

suppliers.[3] Overall, the share of input costs in the total costs of affected firms goes up. While the full adjustment of imports and sales takes place in the year following the shock, the process of adding new suppliers continues for three years (which is the period considered in the analysis).

Second, in line with Acemoglu, Akcigit, and Kerr (2016), we find that the supply shock we consider propagates downstream through the exposed suppliers, but not upstream through the affected domestic buyers. Moreover, we find the effects of the indirect transmission of the shock through domestic suppliers is as large as the effect of the own (i.e., direct) exposure to the shock.

Third, we find that the importers that were liquidity-constrained prior to the RUSF increase are hit harder by the shock: the magnitudes of our coefficient estimates indicate that the liquidity-constrained firms appear to have amplified the propagation of the shock in the production network as compared to unconstrained ones.

Our paper focuses on a particular policy episode that allows us to isolate the effects of a relatively minor and non-localized cost-shock, as such events are typically very difficult to identify compared to larger and localized perturbations. But we believe that our conclusions go beyond the context of the RUSF tax and extend to any setting where adjustment to a cost-push shock requires incurring a fixed cost. For example, a trade war or dissolution of an existing preferential trade agreement (e.g., Brexit) are cost-push shocks that may force firms to find alternative supply sources and incur search costs in the process.[4] Since the latter are more consequential events, our a priori benign regulatory change forms can be thought of providing a lower bound for the effects of larger shocks.

Our paper is closely related to three strands of existing research. First, our work contributes to the literature on the transmission of shocks through production networks, which originated with the work of Acemoglu, Carvalho, Ozdaglar, and Tahbaz-Salehi (2012) and has been extended by others. For example, Barrot and Sauvagnat (2016) show that large economic shocks caused by localized natural disasters in the US, which affect suppliers that are listed on the stock markets, have economically important effects on their client-firms whose shares are traded. Carvalho, Nirei, Saito, and Tahbaz-Salehi (2016) and Boehm, Flaaen, and Pandalai-Nayar (2019) focus on the 2011 Tohoku Earthquake in Japan and provide more evidence on the propagation of shocks through

[3] Though we do not analyze aggregate output or welfare, results by Baqaee and Farhi (2019) imply that even small tariff changes can have first-order effects on both in open economies with distortions.

[4] See Bernard, Moxnes, and Saito (2019) for evidence on how search cost affect formation on buyer-supplier linkages.

production networks. Acemoglu, Akcigit, and Kerr (2016) investigate the impact of various shocks on the American economy using a model of sectoral network structure, which they identify based on the industry-level US input-output tables. They find sizeable network propagation effects for both demand and supply shocks. The demand shocks, such as increases in Chinese imports and changes in US government spending, propagate upstream; whereas the supply shocks, such as those affecting TFP and patenting, tend to be transmitted downstream. We extend this literature by drawing attention to the importance of short-term financial constraints (in the form of low financial liquidity) for shock propagation. Importantly, we show that even a relatively small cost-push shock can propagate through a production network and have a non-negligible impact. We also confirm, with detailed data on firm-to-firm linkages, the sector-level finding of Acemoglu, Akcigit, and Kerr (2016) that a supply shock propagates to downstream firms but has no discernible impact on upstream firms.

Second, our paper extends the literature on the role of financial constraints in production networks (see Acemoglu, Akcigit, and Kerr (2016); Alfaro, García-Santana, and Moral-Benito (Forthcoming); Bigio and La'O (2020); Costello (Forthcoming); Jacobson and von Schedvin (2015); Boissay and Gropp (2013); and Kalemli-Ozcan, Kim, Shin, Sorensen, and Yesiltas (2014)).[5] In contrast to these papers, we are able to examine the firm-level transmission of an unexpected shock through a country's entire production network. Our findings suggest that even relatively minor, non-localized cost-push shocks can have economically non-negligible effects. While the focus of our paper is not about (domestic or foreign) network formation, our results also suggest that, in the face of an input shock, the exposed firms alter their supplier network. They appear to do so by substituting foreign inputs, whose prices went up due to the unexpected regulatory change, with local alternatives from

[5] Bigio and La'O (2020) introduce reduced-form working capital constraints into the Acemoglu, Akcigit, and Kerr (2016) fixed network model to analyze the aggregate impact of firm-level financial constraints. They find that financial constraints prevent firms from producing at the optimal scale and lead to misallocation of labor across sectors. Moreover, an inefficient discrepancy between labor and consumption, and the resulting employment choices, arise in their set-up due to general equilibrium effects. Altinoglu (2018), Reischer (2019) and Luo (2020) use similar frameworks to study the impact of inter-firm trade credit through calibration exercises. Jacobson and von Schedvin (2015) study the exposure of Swedish firms to corporate bankruptcies through trade credit in production chains and find that trade creditors suffer 50% higher losses than banks lending to the corporate sector. Boissay and Gropp (2013) examine the transmission of trade-credit-related payment defaults. They find that credit-constrained firms that are on the receiving end of payment defaults (whose causes cannot be observed in the data) are more likely to pass on a major portion of the related shock through trade credit, which generates additional payment defaults. In contrast, companies that are financially unconstrained help stop the payment default chain. Costello (Forthcoming) uses proprietary data to study firm-level bank credit shocks impact on supplier-buyer relationships, including trade credit.

domestic suppliers.

Finally, our work is also related, albeit less directly, to the growing literature on domestic production networks. On the theoretical front, there has been significant progress in explaining the formation of production networks (e.g. Oberfield (2018), Lim (2018), Tintelnot, Kikkawa, Mogstad, and Dhyne (2019), Huneeus (2018)). On the empirical front, Bernard, Dhyne, Magerman, Manova, and Moxnes (2019) use firm-to-firm trade data similar to ours to study the sources of firm size heterogeneity in Belgium. While we don't study network formation per se, our findings can be seen as a contribution to this literature as we document a substitution between foreign and domestic intermediates in the face of an unexpected cost-push shock.

The rest of the paper is organized as follows. Section 2 describes the exogenous shock that we use for identification in the empirical analysis. Section 3 details the data and variable definitions, while Section 4 outlines the empirical approach. Section 5 presents the main results on the direct and indirect impacts of the shock. The first part of Section 6 describes the simple partial equilibrium theory framework that guides our empirical tests on the role of liquidity constraints in cost-push shock's transmission; whereas the second part of the same section takes these predictions to the data. Section 7 concludes the paper.

2 Institutional Context

The imports-related RUSF contribution was instituted by the Turkish Council of Ministers on May 12, 1988. The management of this import tax, which is considered a statutory import duty by the US Department of Commerce (e.g., ICF 201304), is within the realm of the executive branch, as changes therein do not require a prior parliamentary debate. Before 2011, RUSF imposed a 3% levy on the value of imports involving explicit or implicit non-domestic credit made available during an international trade transaction. In the face of a growing current account deficit, on October 13, 2011, a Council of Ministers' decree unexpectedly increased the RUSF levy on imports from 3% to 6%.

The RUSF tax is administered by the Turkish Customs and Trade Ministry, which requires that all import transactions' details be entered into an electronic database by its officers during the customs clearing process. The resulting dataset allows us to know product and payment details for all imported goods. These are comprehensive since the Turkish Customs' Law no. 4458 imposes high penalties (at the order of three times the mandated RUSF payment, which is proportional to the value of the imported goods) if the RUSF tax is not paid as due or its avoidance is detected.

In practice, the implementation of the RUSF levy is based on the type of internationally defined financing method used in an import transaction. The RUSF statute applies the levy to imports using open account (OA), acceptance credit (AC), and deferred-payment letter of credit (DLC). These three types of international trade financing amount to international trade credit being provided by the foreign exporter to the the Turkish importer. In the case of OA, the payment to exporter is typically due within 30 to 90 days after the receipt of the goods. AC is a type of letter of credit financing that involves a time draft for a delayed payment after receipt of the trade documents. DLC is another type of letter of credit financing with deferred payment, but one that does not involve a time draft.

In contrast, the levy does not apply to cash in advance transactions (in which the importer pre-pays for the goods), transactions financed through a standard letter of credit (in which the payment is guaranteed by the importer's bank provided that the conditions stipulated in the trade contract are met), or documentary collection (which involves bank intermediation without a payment guarantee).

Finally, the RUSF levy applies only to ordinary imports. Processing imports, used in the manufacture of products solely destined for exports, have always been exempted from import taxes in Turkey.[6]

3 Data and Variable Definitions

3.1 Data

To conduct our analysis, we use two Turkish administrative micro-level datasets that can only be accessed on the premises of the Turkish Statistical Institute (TSI) and the Turkish Ministry of Industry and Technology (MoIT).[7]

[6]The fact that processing imports are not subjected to RUSF allows us to use them in a placebo test.

[7]Similar to the US Census micro-data utilization requirements, access to these confidential datasets requires a special permission involving a background check, and the results can only be exported upon approval by the MoIT and TSI staff.

The first dataset, available at the TSI, contains detailed customs data which can be merged with the business survey data. The latter include information on firm-level costs, sales and employment (but no balance sheet data), and cover all firms with more than 20 employees together with a representative sample of small firms. TSI customs dataset allows us to trace the universe of Turkish imports disaggregated by the importing firm, source country, 6-digit Harmonized System (HS6) product code, trade regime (i.e., ordinary or processing), and importantly for our purposes, trade financing type involved (i.e., cash in advance, letter of credit, open account, etc.)

The second administrative dataset that we use is maintained by the MoIT for the purpose of calculating and collecting the value added tax (VAT). The firm-to-firm domestic trade data that are collected by the MoIT cover all domestic between-firm flows so long as the total value of transactions for a seller-buyer pair is above 5,000 Turkish Liras (TLs), or roughly $2,650 (based on the Dec 31, 2011 exchange rate) in a given year. This low annual threshold allows us to observe almost all domestic supplier-buyer pairs in Turkey. Between 2010 and 2014, we are able to trace, on average, roughly 600,000 firms, approximately 6,000,000 buyer-seller connections, with close to 20,000,000 transactions per year. We also match these firm-pair transaction data with corporate financial statements (income statement and balance sheet) as well as the customs data on imports (with one important caveat, see the next paragraph). The financial statement data available allow us to calculate outcome variables (such as sales growth), as well as control variables (such as leverage or liquidity ratios). Finally, the MoIT dataset also reports the 4-digit NACE industry and province-level location of firm, which allow us to include fixed-effects to control for sector- and locality-level unobservables that might otherwise confound our estimates.

While the MoIT dataset covers Turkish firms' imports at the HS6 product code, country, and year level, it does *not* include information on the types of trade financing used. Since the RUSF is charged based on the type of trade financing, the absence of this information in the MoIT dataset prevents us from constructing a direct firm-level measure of exposure to the policy change. Moreover, due to confidentiality reasons, we cannot transfer firm-level import financing information from the TSI dataset and match it with the one at the MoIT. Therefore, we use the TSI data to create a HS6 product code-country-year-level measure of exposure to the RUSF tax based on import financing mode, which we then merge with the MoIT dataset in order to create a Bartik-type instrument. This measure is constructed based on ordinary imports (i.e., it excludes processing imports) and is defined as follows:

$$Exposure_{vt} = \frac{\sum_{m \in \{OA,AC,DLC\}} M_{vmt}}{\sum_m M_{vmt}}$$

where v indexes input variety (i.e., country-product pairs), m trade financing types (including OA, AC, and DLC targeted by RUSF), M denotes imports, and t is the time (i.e., year) index.

The *Exposure* measure covers 150 source-countries, roughly 4,700 HS6 product codes, and corresponds to approximately 75,000 country-product pairs.[8] Figure A1 presents the frequency distribution of $Exposure_{vt}$ for $t = 2011$ (which we consider to be the pre-shock year, as the tax increase took place in mid-October 2011) and $t = 2012$ (henceforth, prefix A denotes Appendix figures and tables). The measure varies between 0 and 1, though zeros are excluded from the figure, in order not to overwhelm the rest of the frequency distribution graph. As illustrated in the figure, the distribution shifted to the left after the increase in the RUSF rate. The average value of the share of imports with foreign source of financing decreased from about 20% before the the shock to roughly 14% afterwards.[9]

In the empirical analysis, we measure *Exposure* as of 2010. However, reliance on external financing at the variety level is quite stable over time. Table A2 shows that the vast majority of the explained variation in $Exposure_{vt}$ over the 2004-2011 period is due to variety-specific factors. Accounting for variations over time across countries or products adds very little to the share of explained variation in $Exposure_{vt}$. To provide further evidence, we regress $Exposure_{vt}$ on time varying country and product fixed effects, as well as time-invariant variety fixed effects. Figure A3 in the Appendix plots $Exposure_{v,t=2010}$ against the estimated variety-level fixed effects from this regression. The correlation between the two measures is high, and the linear slope is close to one. As importers frequently switch products and source countries (e.g. Manova and Zhang (2009)), i.e., the set of importers for a given variety changes over time, this correlation is driven by time-invariant characteristics of varieties. This is the variation we will exploit in our empirical analysis.

[8] As illustrated in Appendix Table A1, there is a lot of variation in *Exposure* across products within source-countries, as well as across source countries within the imported product.

[9] Figure A2 in the Appendix presents the frequency distribution of $Exposure_{v,t}$ based on *processing* imports for the same years and shows no such shift.

Another feature of $Exposure_{v,t=2010}$ is that it pools information from a large and heterogeneous set of importers. Import values are not concentrated among a few firms within a variety: average number of importers per variety is 65, and the average share of an importer in total value of imports is less than one percent (median is about 0.05%, and $99th$ percentile is 17%). These statistics are almost unchanged for varieties with $Exposure_{v,t=2010} > 0$.

As our identification is driven by the increase in a border tax that applies to imported goods with foreign trade financing, we exclude service sector firms. Moreover, we drop micro entities that do not report balance sheets or income statements.[10] These restrictions leave us with a sample of about 60,000 manufacturing firms, for which we observe domestic trade links, detailed income and balance sheet information, and customs records. To these MoIT data, we add the payment-type based HS6 product code-country *Exposure* constructed from the TSI dataset, as explained in the next section.

3.2 Measuring direct exposure to the shock

Firm-level exposure, which is the key variable in our analysis, is constructed as a Bartik-type variable for $t = 2010$ as follows:

$$Exposure_{f,t=2010} = \sum_{v} \omega_{fv,t=2010} \times Exposure_{v,t=2010} \quad (1)$$

where $\omega_{fv,t=2010}$ denotes the share of imports of variety v in firm f's total variable costs (defined as the sum of labor costs, purchases from other domestic firms and imports) at time $t = 2010$. $Exposure_{f,t=2010}$ predicts actual firm-level exposure based on the firm's import composition and the exposure of a given variety ($Exposure_{v,t=2010}$). To investigate the effects of the RUSF tax increase, we construct the following variable that captures the effective tax increase ($\Delta \ln \tau_f$) at the firm-level:

$$\Delta \ln \tau_f = Exposure_{f,t=2010} \times \ln\left(\frac{1+\tau_{2012}}{1+\tau_{2011}}\right) \quad (2)$$

As indicated above, the tax increase took place in the mid-October 2011, so for the purposes of

[10] Such firms keep records using a single-entry bookkeeping system.

our analysis we consider 2011 to be the pre-shock year.[11] However, to be conservative, we create our exposure variable based on 2010 trade figures in order to avoid the possibility of the exposure measure being affected by the policy change.

As explained before, because the customs dataset available at MoIT does not report information on payment methods, we need to rely on a Bartik-type variable to capture the extent to which Turkish firms were affected by the increase in the RUSF rate. It is worth noting that even if the firm-level exposure were directly observable, we would prefer to instrument it with our Bartik-type exposure variable due to potential endogeneity concerns. Therefore, it is important that the Bartik-type exposure is sufficiently relevant for the actual firm-level exposure to the RUSF shock. To check whether our Bartik-type exposure variable in equation (1) tracks the actual exposure well, we use the TSI customs database where the actual exposure can be fully measured using information on payment methods:

$$Exposure^{Actual}_{f,t=2010} \quad = \quad \frac{\sum_{m\in\{OA,AC,DLC\}} M_{f,m,t=2010}}{\text{Total costs}_{f,t=2010}}, \tag{3}$$

where *Total costs* is equal to the sum of the costs of labor and domestic and imported material inputs. Using $Exposure^{Actual}_{f,t=2010}$, we construct the actual effective tax increase as follows:

$$\Delta \ln \tau^{Actual}_f = Exposure^{Actual}_{f,t=2010} \times \ln\left(\frac{1+\tau_{2012}}{1+\tau_{2011}}\right) \tag{4}$$

The distributions of $Exposure_{f,t=2010}$ and $Exposure^{Actual}_{f,t=2010}$ are presented in Figure A4.

[11] If firm-level outcomes were to be affected by the short period (between mid-October and end of December in 2011) during which the higher tax rate was in effect, this would work *against* us finding any impact of the shock in the analysis.

Table 1: **Actual vs. Predicted Exposure to the RUSF Shock**

Dep. vrb.:	$Exposure^{Actual}_{f,t=2010}$	$\Delta \ln \tau^{Actual}_{f}$
	(1)	(2)
$Exposure_{f,t=2010}$	1.071**	
	(0.0554)	
$\Delta \ln \tau_f$		1.068***
		(0.0536)
R^2	0.580	0.582
N	28,825	28,825
Fixed effects	i-r	i-r

Notes: $Exposure_{f,t=2010}$ and $Exposure^{Actual}_{f,t=2010}$ are defined in equations (1) and (3), respectively. Similarly, $\Delta \ln \tau_f$ and $\Delta \ln \tau^{Actual}_{f}$ are defined in equations (2) and (4). Both columns control for industry-region level fixed effects, where industries are defined at the 4-digit NACE level. *, **, *** represent significance at the 10, 5, and 1 percent levels, respectively. Robust standard errors (in parentheses) are clustered at the industry-region level.

To check the informativeness of our Bartik-type instrument, we regress the actual firm-level RUSF exposure that can only be observed in the TSI dataset on the Bartik-type instrument we calculate, and present the results in Table 1. The coefficient estimated in the first column of Table 1 implies that, controlling for industry-region fixed effects, a one-percent increase in the *predicted* firm-level $Exposure_{f,t=2010}$ is associated with a one-percent increase in the *actual* firm-level exposure to the RUSF shock. The second column repeats the exercise for the increase in firm-level effective tax rate $\Delta \ln \tau^{Actual}_{f}$. As expected, the estimated coefficient is almost identical to the one in the first column. We draw two conclusions from these results. First, our Bartik-type exposure variable is highly informative about the actual firm-level exposure to the RUSF shock.[12] This is not surprising given our earlier result that time-invariant variety-specific characteristics constitute the primary source of variation in the reliance of imports on external financing. Second, the magnitudes of the estimates presented in Table 1 are not statistically different from one. This implies that 2SLS regression, where the Bartik-type exposure variable constitutes an instrument for the actual firm-level exposure, would generate an estimate that is is very close to the reduced-form

[12]The respective values of R^2 in the first and second columns are 0.580 and 0.582. The second column corresponds to our first-stage, and the F-statistic for the instrument is 594.3.

estimate.[13]

Our Bartik-type (shift-share) instrument is constructed from a large number of highly dispersed "shocks" (i.e., $Exposure_{v,t=2010}$) distributed heterogeneously across firms in different industries and regions. In a recent paper, Borusyak, Hull, and Jaravel (2018) study the conditions under which identification can be achieved in shift-share instrumental variable regressions through the quasi-random assignment of shocks even when exposure shares are endogenous. Here, we discuss those conditions in our setting. First, we already established in the previous paragraph that $Exposure_{f,t=2010}$ is highly informative about importing firms' actual reliance on external financing. Second, our shocks are generated via imports (given the trade-financing type) from about 150 distinct source countries and 4,700 6-digit HS codes, which amounts to a large number (approximately 75,000) unique varieties. Third, these shocks are highly dispersed: the standard deviation of $Exposure_{v,t=2010}$ is 0.28 for all varieties, and 0.31 for varieties with $Exposure_{v,t=2010} > 0$. The interquartile range for the latter sample is 0.40. Borusyak, Hull, and Jaravel (2018) show that the "shocks" view to identification in shift-share instrumental variable regressions relies on an important condition: average importance of any shock should be sufficiently small. To illustrate this in our data, we construct average import share of each variety across importers: $\omega_v = \sum_f (1/N)\omega_{fv,t=2010}$. The condition requires that even the largest ω_v must be small. In our data, its value varies between (approximately) zero and 0.004. Both the mean and median values are close to zero. The concentration of shocks, as measured by the Herfindahl–Hirschman Index, is also low. The inverse of this index is informative about the effective number of shocks, which is about 36,388 in our data. Based on these statistics, we believe identification is achieved in our setting through firm-level "shocks" even in the presence of possibly endogenous shares.

[13] In an exactly identified model with one endogenous variable, the following relationship holds between the 2SLS estimate (β^{2SLS}) and the reduced form estimate (β^{RF}), which is obtained by regressing the outcome variable directly on the instrument: $\beta^{2SLS} = \frac{\beta^{RF}}{\beta^{FS}}$, where β^{FS} denotes the first-stage estimate. As the estimated coefficient in the second column of Table 1 (which corresponds to β^{FS} in this context) is not statistically different from one, the values of 2SLS and reduced-form estimates would be very close. We confirm this later in Table A6.

3.3 Measuring indirect exposure to the shock

We are also interested in measuring firms' indirect exposure via their domestic suppliers and domestic buyers. To capture the former, we define:

$$Exposure^{Suppliers}_{f,t=2010} = \sum_s \omega^S_{f,s,t=2010} \times Exposure_{s,t=2010} \tag{5}$$

where $Exposure^{Suppliers}_{f,t=2010}$ is the firm f's exposure to the shock through its suppliers; and $\omega^S_{f,s,t=2010}$ is the share of supplier s in firm f's total variable costs (defined as the sum of labor costs, purchases from other domestic firms and imports) in year 2010. In a similar fashion, we also construct firm f's exposure to RUSF levy increase through its domestic buyers, indexed by b:

$$Exposure^{Buyers}_{f,t=2010} = \sum_b \omega^B_{f,b,t=2010} \times Exposure_{b,t=2010} \tag{6}$$

where $\omega^B_{f,b,t=2010}$ is the share of buyer b in firm f's total sales in year 2010. As we did for the direct exposure to the RUSF shock, we construct the following variables that capture the effective tax increase at the firm-level through the firm's suppliers and buyers:

$$\Delta \ln \tau^{Suppliers}_f = Exposure^{Suppliers}_{f,t=2010} \times \ln\left(\frac{\tau_{2012}}{\tau_{2011}}\right) \tag{7}$$

$$\Delta \ln \tau^{Buyers}_f = Exposure^{Buyers}_{f,t=2010} \times \ln\left(\frac{\tau_{2012}}{\tau_{2011}}\right) \tag{8}$$

We construct additional variables to capture the firm's exposure to the RUSF-levy increase through its second-degree vertical (*suppliers-of-suppliers* denoted by SoS and *buyers-of-buyers* denoted by BoB) linkages:[14]

$$\begin{aligned} Exposure^{SoS}_{f,t=2010} &= \sum_s \omega^S_{f,s,t=2010} \times Exposure^{Suppliers}_{s,t=2010} \\ Exposure^{BoB}_{f,t=2010} &= \sum_b \omega^B_{f,b,t=2010} \times Exposure^{Buyers}_{b,t=2010} \end{aligned} \tag{9}$$

The summary statistics for the various exposure measures introduced above are presented in Table A3. As expected, most firms do not import and hence have no direct exposure to the

[14] See Figure A7 for an illustration.

RUSF tax. To see this, we present below an alternative representation of our Bartik-type exposure variable, which has two components: the predicted share of firm's imports subject to the RUSF tax ($Exposure^M$) and firm's import intensity (i.e., the share of imported inputs in firm's variable costs):

$$
\begin{aligned}
Exposure_{f,t=2010} &= \sum_v \omega_{f,v,t=2010} \times Exposure_{v,t=2010} \\
&= \sum_v \frac{M_{f,v,t=2010}}{TotalCosts_{f,t=2010}} \times Exposure_{v,t=2010} \\
&= \sum_v \frac{M_{f,v,t=2010}}{TotalCosts_{f,t=2010}} \times \frac{M_{f,t=2010}}{M_{f,t=2010}} \times Exposure_{v,t=2010} \\
&= \underbrace{\frac{M_{f,t=2010}}{TotalCosts_{f,t=2010}}}_{\text{Import intensity}} \times \underbrace{\overbrace{\sum_v \frac{M_{v,f,t=2010}}{M_{f,t=2010}} \times Exposure_{v,t=2010}}^{Exposure^M_{f,t=2010}}}_{\text{Share of firm's imports subject to RUSF}} \qquad (10)
\end{aligned}
$$

The median direct exposure in the sample is zero. For importers, the average direct exposure amounts to 1.8% of the total variable costs. This low level exposure is primarily due to small import intensity as the average value of $Exposure^M$ is 17% among importers. Table A3 shows that almost all firms are indirectly exposed to the tax via their suppliers or customers. The median value of exposure via suppliers and customers equals 0.3% and 0.1%, respectively. These figures are only slightly higher for importers.

4 Empirical Strategy

4.1 Was the shock anticipated?

For our identification strategy it is crucial that the increase in the RUSF rate in October 2011 was unanticipated. Here, we provide two pieces of evidence that strongly suggest that the increase was unexpected. First, the Google Trends statistics for the number of searches involving "Kaynak Kullanımını Destekleme Fonu" (which is the Turkish name of the tax) or "KKDF" (its acronym) presented in Figure A5, do not show any pattern suggestive of the regulatory change being anticipated before the week of 9 October 2011. In fact, the number of searches increase all of a sudden during that particular week. Second, Figure A6 shows that inventories of the firms that were more exposed to the increase in the RUSF rate do not show any sign of adjustment prior to the date of the policy change. These observations support our claim that the tax increase was indeed unanticipated. Later, in Section 5.1.3, we provide formal statistical tests, which confirm that there were no pre-existing trends in any of the outcome variables that we focus on in the estimation.

4.2 Is the focus on just domestic suppliers justified?

In the face of the higher RUSF duty, the importing firms that relied on one of the international trade financing methods (i.e., OA, AC, or DLC) that exposed them to the tax rise, had few alternatives to consider. One possibility is that they avoided the tax altogether by switching to cash-in-advance payment, in which case they would have to increase their working capital (i.e., cash that is devoted to their operations). Another way to avoid RUSF completely was to switch to domestic suppliers of same inputs or their substitutes presuming that they existed at acceptable quality and price. The importing firms weighed the costs of these options against paying the higher RUSF tax and preserving their pre-shock foreign input supplier. The default course of action for the importing firms was to continue buying from the same exporter under the same conditions, but now pay a 100% higher RUSF tax.

For all these reasons, it is reasonable for our analysis to consider only changes to the domestic supplier network. Searching for new foreign suppliers would be the dominated strategy for all importers: not only they would need to pay (potentially higher than domestic) search costs for new foreign suppliers, but still face the same international trade financing cost increases either via cash-in-advance terms or paying the tax on open account transactions.

4.3 Did the shock affect payment terms in import transactions?

As a first pass at the data, we investigate whether importers responded to the increase in the RUSF tax rate by changing the composition of the payment terms of their imports after October 2011 to avoid the RUSF duty. To do so, we use the TSI dataset which reports imports disaggregated by financing terms. Table A4 shows that at least some firms that were using RUSF-affected import-payment terms more intensively before the date of the policy change, to the extent that they could afford it financially, switched into international trade financing choices that are not subjected to the higher tax (more on this in Section 6 below). Another implication of the results presented in Table A4 is that the actual firm-level exposure and the Bartik-type exposure defined in equation (1) yield very similar estimates, which gives us confidence in the identification approach we pursue in our core analysis.

4.4 Estimating equation: Baseline analysis

We start our main analysis with the baseline specification, in which we focus on the direct impact of the tax increase, while in the later specifications we consider both the direct and the indirect effects of higher RUSF. The baseline regression takes the form of a difference-in-differences model with a differenced dependent variable between pre- (i.e., $t-1$=2011) and post-shock (i.e., t=2012) periods:[15]

$$\Delta \ln Y_f \quad = \quad \beta \Delta \ln \tau_f + \Theta X_{f,t=2010} + \alpha_{i,r} + \epsilon_f \tag{11}$$

where, Y_f is an outcome variable (e.g., sales) for firm f operating in industry i and region r; $\Delta \ln Y_f$ is the annual change in the logarithm of Y between $t-1$ and t.[16] $X_{f,t=2010}$ vector represents firm-level control variables such as initial size and import intensity (share of cost of imported inputs in total costs). The latter is particularly important as the shares in our Bartik-type variable are incomplete: since the denominator of $\omega_{fv,t=2010}$ in equation (10) is the firm's total costs rather than its total imports, the shares do not add up to one at the firm level. In this, we follow Borusyak, Hull, and Jaravel (2018) who suggest controlling for incomplete shares in the regression as failing to do so could pose a threat to identification. Moreover, adding the initial import intensity of firms to the specification controls for other trade related shocks such as exchange rate movements.[17]

The specification in equation (11) also controls for industry-region fixed effects, $\alpha_{i,r}$ where i denotes one of the 22 two-digit NACE industry segments; and r corresponds to the 81 contiguous

[15] Further on, we investigate whether the shock has medium term effects by estimating the baseline specification between 2013-2012 and 2014-2013. These regressions would inform us about duration of the shock as well as its cumulative impact over time.

[16] If firm-level outcomes were affected by the higher tax rate during the last 2.5 months that followed RUSF adoption on October 13, 2020, this will work *against* us finding any impact of the shock in the analysis.

[17] As shown by Gopinath and Neiman (2014), exchange rates movements affect the use of imported inputs. However, because 97% of Turkish imports during the period under study were denominated in foreign currencies, changes in import intensity will reflect changes in exchange rates. Nevertheless, we will revisit the issue of exchange rate movements in our robustness checks.

administrative regions into which Turkey is subdivided, with each region corresponding to a Turkish city (such as Ankara, Istanbul, Izmir, etc.). These fixed effects control for confounding factors or shocks that could vary at the economy, industry, region, or industry-region levels. As our firm-level dependent variable is differenced, firm-level time-invariant unobservables, which might otherwise have an influence on our results, are also eliminated. In all regressions, standard errors are clustered at the industry-and-region (i.e., i and r) level.[18]

In equation (11), β is the tax elasticity of the outcome variable Y_f. It is composed of two parts: (i) elasticity of price with respect to RUSF tax ($\frac{\partial \ln p_f}{\partial ln \tau_f}$), and (ii) price elasticity of Y_f. The latter is equal to $(1 - \varepsilon_H)$ under CES demand with elasticity ε_H.[19] We can recover the value of the tax elasticity of price by assuming a value for ε_H based on existing estimates from the literature. The size of this elasticity depends on the pass-through of taxes onto costs and firm's mark-ups.

Our extended specification includes additional variables capturing a firm's exposure to the shock via its suppliers and buyers:

$$\Delta \ln Y_f \quad = \quad \gamma \Delta \ln \tau_f + \gamma_s \Delta \ln \tau_f^{Suppliers} + \gamma_b \Delta \ln \tau_f^{Buyers} + \Gamma X_{f,t=2010} + \alpha_{i,r} + \upsilon_f \qquad (12)$$

where, $\Delta \ln Y_f$, $\Delta \ln \tau_f$, $\Delta \ln \tau_f^{Suppliers}$, $\Delta \ln \tau_f^{Buyers}$, and α_{ir} are as defined under section 3.3. We use several variants of equation (12) in our analysis.

5 Results

5.1 Direct effect of the shock

5.1.1 Direct effect of the shock on the sourcing pattern

We begin by examining the direct effect of the unexpected RUSF duty increase from 3% to 6% on the input sourcing pattern. For the time being, we ignore the network effects. We expect directly exposed firms to move away from imported inputs and increase their reliance on domestic sourcing from local suppliers. Our findings below confirm that such a substitution does indeed take place.

[18] Our results are robust to clustering standard errors at the 4-digit NACE industry-segments. The number of 2-digit manufacturing industries in NACE classification is not sufficiently large for us to use as our alternative clustering variable.

[19] See Appendix A.3.1 for a derivation of the two effects in equation (40). There is also a negligible effect due to substitution between foreign and domestic intermediates that we ignore here.

Table 2: **Direct Effects of the Shock**

Dep var:	$\Delta_{11-12}\left(\frac{\text{Imports}}{\text{Total input purchases}}\right)_f$	$\Delta_{11-12}\left(\frac{\text{Total input purchases}}{\text{Total costs}}\right)_f$	$\left(\frac{\text{New suppliers in 2012}}{\text{Suppliers in 2010}}\right)_f$	$\Delta_{11-12}\ln Sales_f$
$\Delta\ln\tau_f$	**-1.273*****	**1.318*****	**19.97*****	**-6.231****
	(0.262)	(0.367)	(5.003)	(2.558)
$\ln \text{Employment}_{f,t=2010}$	-0.0002***	0.0029***	0.0049**	0.0004
	(0.0000)	(0.0002)	(4.803)	(0.0014)
Import Intensity$_{f,2010}$	-0.0023***	-0.0000	0.0156**	-0.0092*
	(0.0002)	(0.0006)	(0.0072)	(0.0050)
R^2	0.032	0.032	0.032	0.026
N	54,968	54,968	54,968	54,968
Fixed effects	i-r	i-r	i-r	i-r

Notes: This table shows the results from estimating specification in equation (11) where the dependent variable changes across columns as follows. It is the annual change in the share of imports in total input purchases in column (1), annual change in the share of input purchases in total costs (where total costs are defined as input purchases and wages) in column (2), new domestic supplier links established in 2012 in column (3), and the growth rate of sales of firm f operating in industry i and located in region r in column (4). τ_f captures the firm-level effective tax rate, as defined in equation (2). $\ln \text{Employment}_{f,t=2010}$ is the logarithm of the number of employees, and Import Intensity$_{f,2010}$ the share of imports in total costs of firm f in 2010. The fixed effects are at the industry-region (ir) level. *, **, *** represent significance at the 10, 5, and 1 percent levels, respectively. Robust standard errors (in parentheses) are clustered at the industry-region level.

In the first column of Table 2, we consider the annual change in the share of imports in total value of input purchases taking place after the RUSF increase. The coefficient estimate for the increase in the effective tax rate is negative and statistically significant at the 1%-level: the increase in the RUSF tax has discouraged exposed firms from using imported inputs. The implied elasticity of imports (as a fraction of total input purchases) calculated for the average importer that imports about half of its inputs is 2.6.[20]

In the second column of Table 2, the dependent variable is the change in the share of input purchases in total costs (where total costs are defined as input purchases and wages).[21] The estimated coefficient on $\Delta\tau_f$ is positive and statistically significant, implying that firms exposed to the shock experienced an increase in their input costs relative to their overall costs. To the extent that the exposed firms pass this cost increase into their prices, the shock will affect their buyers regardless of whether they are themselves directly affected by the shock or not. Therefore, this result provides the first piece of evidence for the network channel of shock propagation that we

[20]The estimated elasticity is $\hat{\beta}/0.49$.

[21]Since MoIT dataset does not report firm output in terms of quantities produced, it is not possible to calculate the average costs. Therefore, we normalize input costs by overall costs.

investigate further in the paper.

Consistent with the observed decrease in the imported goods as a fraction of total input purchases, firms directly exposed to the tax appear to have substituted foreign inputs with domestic ones. This is illustrated in the third column of Table 2, where the outcome variable is the number of new domestic suppliers in 2012, normalized by the number of firm's domestic suppliers in 2010. A new domestic supplier is defined as one from which the firm in question did not make any purchases at $t = 2010$ or $t = 2011$. The coefficient of interest is positive and statistically significant at the 1%-level. The estimate suggests that a one-standard-deviation increase in the RUSF exposure for an importer is associated with one new domestic supplier.[22]

Turning to the control variables, the estimated coefficients on the pre-shock employment do not seem to suggest an economically meaningful impact. We note that pre-shock import intensity is positively correlated with the number of new domestic suppliers added after the tax change. Finally, we note that our findings are robust to excluding the control variables.

5.1.2 Direct effect of the shock on sales

Next, we focus on the direct effect of the shock on the affected firms' performance, which we measure in terms of sales. In the last column of Table 2, the dependent variable is defined as the log change in sales between 2011 and 2012. As visible in the table, the tax shock had a negative and statistically significant impact on sales of the affected firms. The coefficient estimate β for $\Delta \ln \tau_f$ is equal to -6.2, and it is statistically significant at the 5%-level. This result is consistent with the earlier observation about the increase in input costs in the year following the RUSF shock (see column (2) of the same table).

To interpret the magnitude of this effect, recall from Section 3.2 that β, the estimate of the tax elasticity of the outcome variable, here sales, is equal to the product of the two other elasticities $\frac{\partial \ln p_f}{\partial ln \tau_f} \times (1 - \varepsilon_H)$. To recover the value of the elasticity of price with respect to tax, we assume the price elasticity of demand to be $\varepsilon_H = 5$ (Broda and Weinstein (2006)). This gives a passthrough rate of tax to prices of about 1.5, which is comparable to the estimates of tariff passthrough onto

[22] The estimated effect is calculated as follows: $\hat{\beta} \times Std(Exposure_f) \times \Delta\tau \times$ Avg(Number of domestic suppliers) $= 19.97 \times 0.035 \times 0.03 \times 46.7$. Note that the statistics used in the calculations are derived from the sample of importers.

producer prices reported in a recent paper by Amiti, Redding, and Weinstein (2019).[23] Assuming a less conservative estimate for price elasticity of demand implies a lower passthrough rate. For instance, assuming $\varepsilon_H = 9.65$, based on the estimates reported by Head and Ries (2001), would imply a passthrough rate of tax onto prices of 0.7.[24] Depending on the assumed value of price elasticity of demand, a one standard deviation increase in *Exposure* for importers ranges between 0.07% and 0.15% increase in the estimated price response.[25]

To gauge the economic significance of the estimated effect on sales, let us consider a one-standard-deviation increase in *Exposure*. Our baseline estimate implies a 0.65% decline in sales for such importer. This effect is economically important as the average sales growth between 2011-2012 observed in the data is 9%.

5.1.3 Robustness tests

Pre-trends and placebo tests As the first robustness check, Figure 1 shows results from a panel estimation over the period 2010-2014 with a richer set of fixed effects compared to the baseline equation in (11):

$$\Delta Y_{ft} = \sum_{l=2012}^{2014} \beta_l \left(D_t^l * \Delta \ln \tau_f \right) + \sum_{l=2012}^{2014} \theta_l \left(D_t^l * X_{f,2010} \right) + \alpha_{NACE4,r} + \alpha_{NACE4,t} + \alpha_{rt} + e_{ft} \quad (13)$$

In particular, this specification controls for time-varying industry-level shocks and industry composition of regions at a finer level (4-digit NACE) compared to the baseline (2-digit NACE). The estimated coefficients for the year 2012 are broadly similar to the baseline estimates. More importantly, including observations for 2010 and 2011 allows us to test for the existence of pre-trends in the relationship between the firm-level outcome and its exposure to the RUSF shock, while includ-

[23] Using the tariff changes introduced during the 2018 trade war, Amiti, Redding, and Weinstein (2019) estimate that the passthrough rate of input tariffs onto domestic producer prices is 1.8. In another paper, Fajgelbaum, Goldberg, Kennedy, and Khandelwal (2019) also exploit the recent changes in the US trade policy and report a complete passthrough of the tariffs to import prices.

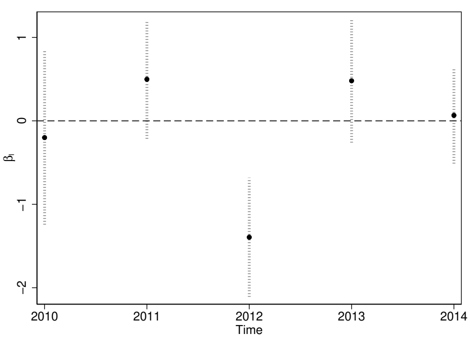
[24] Head and Ries (2001) estimate price elasticities focusing on the US-Canada trade. As the two economies are very similar, we believe that their estimates may be more appropriate in our within-Turkey context than others available in the literature. Head and Ries (2001) obtain price elasticities of demand ranging between 7.9 and 11.4 depending on the specification. In our calculations, we use the average of these two values, namely 9.65.

[25] One can cite additional factors that may play a role increasing the tax passthrough. For example, RUSF introduction may nudge firms to increase their prices earlier than planned – as shown by Gagnon (2009) prices can be staggered even in economies with medium inflation. Moreover, as exposed firms move away from foreign intermediates (as documented in section 5.1.1), they bear search costs and adjustment costs for the usage of new intermediate inputs. In the short run, these are likely to increase the variable costs.

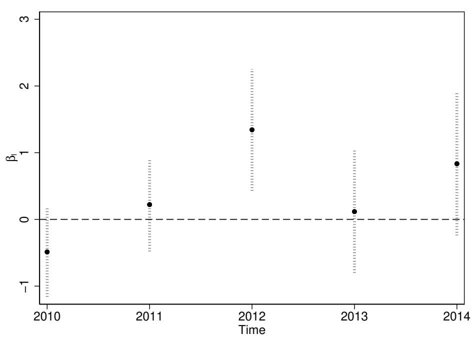
ing later years is useful for understanding the persistence of the effects. For all outcome variables the coefficient estimates for pre-shock years (2010 and 2011) are small in magnitude and not significantly different from zero. This finding is reassuring for the identification strategy: it suggests that the assumption of parallel trends for the treated and control groups in the pre-treatment period, which is a prerequisite for a valid difference-in-differences estimation, cannot be rejected. Second, the RUSF shock seems to have a level effect on all outcomes except for the exposed firm's new domestic supplier linkages. In other words, the adjustment to imported inputs and sales taking place in 2012 is not followed by further changes in the subsequent years. The finding that adjustment to the domestic supplier network continues beyond 2012 is consistent with the fact that it takes time to switch from imported inputs purchased from foreign suppliers to domestically produced ones.

Figure 1: Direct Effect of the Shock: Lags and leads

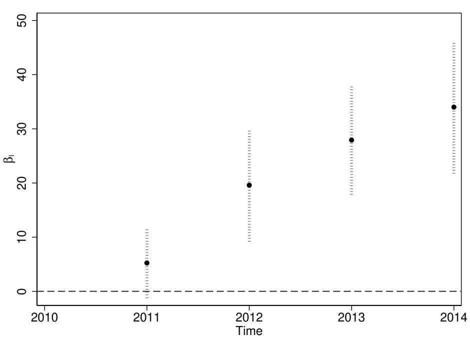
(a) Change in share of imported inputs



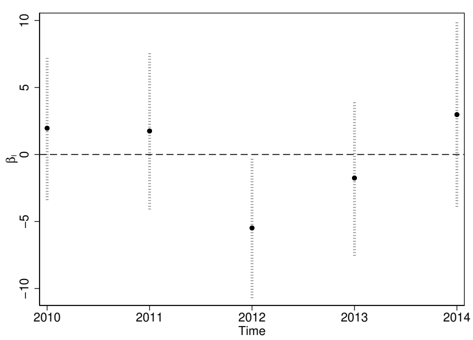
(b) Change in share of material input costs



(a) Change in new domestic suppliers relative to 2010



(b) Change in log of sales



Notes: The figure plots the estimates of β_l, together with 95% confidence intervals, obtained from estimating the specification in (13). Dependent variable changes across sub-figures as clearly stated in the titles. Robust standard errors (in parentheses) are clustered at the 2-digit NACE and region level.

To verify that the coefficient estimates that we observe in Table 2 are really driven by the changes in the RUSF tax, we conduct a placebo test for which we construct τ_f based on $Exposure^{Processing}_{f,t=2010}$ using data on firms' processing imports and actual RUSF taxes of τ_{2011}=0.03 and τ_{2012}=0.06. Since the RUSF does not apply to processing imports, we should not see any response of firm-level outcomes to this placebo exposure measure. The results presented in Table A5 are consistent with this prior: the estimated coefficients of $\Delta \ln \tau_f$ are not economically or statistically significant for any of the outcome variables. These results lend further credibility to our baseline results.

Additional controls In a set of robustness checks, we examine whether our baseline estimates are driven by omitted variables. In particular, we include additional control variables in the baseline specification, which are constructed using similar shares as in equation (1) and shifts that are potentially correlated with $Exposure_{v,t=2010}$. As discussed in Borusyak, Hull, and Jaravel (2018), adding such controls in the estimation is useful not only for consistency but also to obtain valid inference.[26]

First, reliance of Turkish firms on external financing when importing a particular product could be correlated with economic developments in the source-country during the same period to the extent that such developments affect the product's price. To account for this possibility, we add to the baseline specification a weighted average of changes in source-country real per capita GDP between 2010 and 2012: Weighted GDPpc growth$_f$ = $\sum_c \omega_{fc,t=2010} \times$ GDPpc growth$_c^{2010-2012}$, where $\omega_{fc,t=2010}$ is the share of source country c in firm's total costs as of 2010. The results are presented in panel B of Table A5. For all outcome variables, the estimates obtained for the variable of interest are very close to the baseline estimates.

Another potential threat to our identification strategy is exchange rate movements. Depreciation of TL during the same period would increase the price of imported inputs and trigger a chain of events (broadly) similar to the increase in RUSF rate. This concern is alleviated by the fact that the share of USD-denominated imports was 62% in 2011-2012, with the rest distributed between

[26] Adao, Kolesár, and Morales (2019) also discuss inference in settings similar to ours and propose methods to obtain valid inference.

Euro (33%), and TL (3%), and other currencies (2%). As a result, adding the firm's initial import intensity as a control variable captures its overall exchange rate risk prior to the RUSF-shock. However, one could still be concerned about cross-currency movements: if switches between USD and Euro are associated with switches between payment methods, then exposure to RUSF would be correlated with exposure to cross-currency risk. To address this concern, we construct a Bartik-type variable that is very similar to $Exposure_f$ but replaces the shifts in equation (1) with the share of USD-denomonated imports at the variety level as of 2010. As reported in panel C of Table A5, our results are robust to this additional control variable.

Finally, we check whether accounting for exposed firms' capital structure, which is likely to be representative of their longer-term financial constraints, matters for the baseline results. In the bottom panel of Table A5, we add the leverage variable, defined as the ratio of total debt to total assets, calculated as of 2010 as an additional control to the baseline specification. Including the leverage ratio as a control does not affect the estimates for β or their statistical significance in any of the four columns. We conclude that the firms' *long-term* financing structure (i.e., financial contraints) does not affect its response to the RUSF increase. That said, the *short-term* financial constraints (i.e., access to liquidity) might, something we examine in Section 6.

Alternative sample and 2SLS estimation As discussed in Section 3.2, data on actual firm-level RUSF exposure are available in the TSI dataset but not in the MoIT dataset. Using just the TSI data, we were able to show that our Bartik-type instrument is highly informative about the actual firm-level exposure (recall Table 1). Moreover, the coefficient estimated in the first stage was not statistically different from unity, implying that 2SLS estimation, where $Exposure_{f,t=2010}$ is used as an instrument for the actual firm-level RUSF exposure, would yield an estimate that is very close to the reduced-form estimate (i.e., our baseline estimates).

We confirm this in Table A6 where we examine the impact of the shock on firm sales using the TSI as well as the MoIT datasets. We have to restrict our attention to gross sales, as it is the only outcome variable that we can construct using both datasets in a comparable way. In the former, we observe the *actual* firm-level exposure to the RUSF tax change, while in the latter we have to rely on the exposure *predicted* based on the composition of firm-level imports.

We start with the TSI dataset. In the first column of Table A6, we estimate an OLS regression relating changes in firm's sales to change in the *actual* firm-level exposure to the RUSF tax shock. As expected, we obtain a negative and highly significant coefficient. Next, we instrument the *actual* exposure with the *predicted* exposure, and again obtain a negative and highly significant coefficient of interest (see second and third columns). In the final column, we turn to the MoIT, where only the predicted exposure is available, and estimate an OLS specification.

The take-away message from this exercise is that the estimates from the reduced form approach are very close to those obtained from the IV specification. This validates our choice of relying on MoIT data whose main advantage is observing firm-to-firm linkages that will allow us to investigate propagation of the shock through production networks.

5.2 Network effects of the RUSF shock

Next, we examine whether the RUSF shock propagates beyond the directly exposed firms, using the regression equation (12). We consider the same firm-level outcomes as before, namely annual change in the share of imports in total input purchases, share of input purchases in total costs, new domestic supplier links, and sales. The results, presented in Table 3, follow the same format as the earlier tables.

Three observations emerge from Table 3. First, after adding the indirect exposures through suppliers and buyers, the direct exposure effects retain their order of magnitude and statistical significance reported in Table 2: directly exposed firms reduced their reliance on imported inputs, experienced an increase in the cost of their input purchases, expanded their domestic supplier network, and suffered lower sales growth compared to non-exposed firms.

Table 3: **Direct and Indirect Effects of the Shock**

Dep var:	$\Delta_{11-12}\left(\frac{\text{Imports}}{\text{Total input purchases}}\right)_f$	$\Delta_{11-12}\left(\frac{\text{Total input purchases}}{\text{Total costs}}\right)_f$	$\left(\frac{\text{New suppliers in 2012}}{\text{Suppliers in 2010}}\right)_f$	$\Delta_{11-12}\ln Sales_f$
	(1)	(2)	(3)	(4)
$\Delta\ln\tau_f$	**-1.277** ***	**1.381*****	**19.39*****	**-5.334****
	(0.262)	(0.369)	(5.230)	(2.658)
$\Delta\ln\tau_f^{Suppliers}$	-0.109	**1.409****	-12.97	**-7.042****
	(0.111)	(0.624)	(10.36)	(3.559)
$\Delta\ln\tau_f^{Buyers}$	0.005	-0.001	0.778	-0.003
	(0.004)	(0.005)	(0.551)	(0.002)
R^2	0.0317	0.0318	0.0316	0.0265
N	54,968	54,968	54,968	54,968
Fixed effects	i-r	i-r	i-r	i-r
Firm-level controls	Yes	Yes	Yes	Yes

Notes: This table shows the results from estimating specification in equation (12) where the dependent variable changes across columns as follows. It is the annual change in the share of imports in total input purchases in column (1), annual change in the share of input purchases in total costs (where total costs are defined as input purchases and wages) in column (2), new domestic supplier links established in 2012 in column (3), and the growth rate of sales of firm f operating in industry i and located in region r in column (4). τ_f captures the firm-level effective tax rate, as defined in equation (2). $\tau_f^{Suppliers}$ and τ_f^{Buyers} are defined similarly in equations (7) and (8). All columns include $\ln \text{Employment}_{f,t=2010}$, i.e. the logarithm of the number of employees, and Import $\text{Intensity}_{f,2010}$, i.e. the share of imports in total costs of firm f in 2010, as additional controls. The fixed effects are at the industry-region (ir) level. *, **, *** represent significance at the 10, 5, and 1 percent levels, respectively. Robust standard errors (in parentheses) are clustered at the industry-region level.

Second, and more importantly, we find evidence of a downstream propagation of the RUSF shock from suppliers to their customers, as indicated by a decrease in the sales growth of the latter. In other words, we observe that firms are indirectly affected by the shock if their suppliers are exposed to the RUSF increase. This finding, which is separate from firms' possible own-shock exposure, is consistent with a pricing channel, assuming that (i) importers reflect RUSF increase in their prices, and (ii) switching from shocked importer-suppliers to domestic-suppliers is costly, at least in the short-term. Indeed, in the second column, we find that firms that are exposed to the RUSF increase through their suppliers experience an increase in the cost of their input purchases. The estimated coefficient on $\Delta\ln\tau_f^{Suppliers}$ in the fourth column is equal to -7.0 and statistically significant at the 5%-level. While its magnitude looks slightly larger than the magnitude of the direct effect, in unreported tests we find that these two are not statistically different from each other. This suggests that, for an equal-sized direct exposure and supplier-driven exposure to the RUSF increase, the effect on sales through suppliers is comparable to the direct effect.

Third, and equally importantly, we find no evidence of upstream propagation of the shock from the exposed buyers to their domestic suppliers. The coefficient on $\Delta \ln \tau_f^{Buyers}$ is small and statistically insignificant for all of the outcome variables presented in Table 3.

In another exercise, presented in Table A7, we consider the sum of both first and second degree linkages in the production network, as defined in equations (5)-(9). The results confirm the conclusions from Table 3. The estimates obtained when using the cumulative first- and second-order exposures are very similar in magnitude.[27]

In sum, we conclude that the increased tax burden has affected firms' sales in the short term through two channels: (i) directly through own exposure if they are importing in ways covered by RUSF, and (ii) indirectly via their suppliers. Moreover, we find that the impact of the shock that travels downstream through the production network is comparable to the direct effect on the exposed firms. However, we find no empirical evidence that the RUSF shock travels upstream in the domestic production network. These findings are consistent with the predictions of Acemoglu, Akcigit, and Kerr (2016). We conclude that even a relatively small, non-localized cost-push shock can propagate and get magnified through the production networks.

6 Role of Liquidity Constraints

The results of Section 5 indicate that, what is a relatively small, non-localized input-cost shock, can have a non-trivial impact on firms' sales through both direct (own-exposure) and indirect (suppliers' exposure) channels. We also find that the negative effects of the shock are short lived as the affected firms switch to domestic input substitutes within a short time period (Figure 1).

That said, it is unlikely that all firms are affected the same way by the input-cost shock: to the extent their short-term financial condition, i.e., their liquidity position, allows it, at least a certain fraction of firms ought to be able to avoid or dampen the effect of the RUSF increase on their input costs. In order to do so, firms could cease importing based on international trade credit terms that expose them to the RUSF import levy. Alternatively, albeit less likely, they could continue to import and pay the higher RUSF duty but not pass it into their prices. Given the unexpected nature of the tax increase, it makes economic sense that the way firms would avoid

[27] Adding higher order network exposures does not affect the size of the respective estimates.

(or fail to avoid) the RUSF depends on their short-term financial condition: firms rich in cash or cash equivalents ought to be able to avoid (or at least dampen) the effect of the tax increase by switching (at least partially) to cash-in-advance payment (for at least some of their imported inputs). As a result, RUSF-exposed firms' reaction to the tax increase should differ depending on their short-term financial capacity. This channel would suggest that the above observed effect would be concentrated in liquidity-constrained firms that cannot avoid the tax. In contrast, RUSF-exposed firms that are (relatively) *liquidity-rich* would either be unaffected by the shock, or at a minimum, be less impacted by the import duty increase.

To fix these ideas more formally, the next subsection presents the predictions from a simple theoretical framework (with the full model and calculations being presented in Appendix A), in which we focus on firm's sales to other firms, as this is what we can observe in data. In subsection 6.2, we take these predictions to the data and confirm that firm's liquidity constraints indeed amplify the impact of the shock, and this for both direct and indirect (supplier) channels.

6.1 Theoretical predictions

We introduce the import-payment-type decision into a partial-equilibrium static model of a small open production economy with firm networks. This framework provides a simple, yet useful, setting for understanding the propagation of a cost shock, such as an increase in the RUSF rate, in a production network. Importantly, the model allows us to illustrate how liquidity constraints affect the propagation of the cost-push shock.

6.1.1 Firms and production

Assume a fixed number of firms n, indexed by f, which combine labor, capital, and N composite intermediate inputs to produce a single distinct variety according to the following production function:

$$Q_f = A_f K_f^{\alpha} L_f^{\beta} \Pi_{v=1}^{N} \left(X_{f,v}\right)^{\gamma_v} \tag{14}$$

where, A_f is the firm-specific productivity shifter; K_f denotes the capital input needed for the production, L_f the labor input, X_{fv} the composite input variety v used by firm f (see equation

15 below). We assume that $\alpha + \beta + \sum_{v=1}^{N} \gamma_v = 1$, i.e., a constant returns to scale technology. Each firm minimizes its production costs, taking the input prices as given. Each composite input v is represented as a constant elasticity of substitution (CES) aggregate of domestic and imported material inputs:

$$X_{f,v} = \left(a^{\frac{1}{\varepsilon_X}} \left(X_{f,v}^F \right)^{\frac{\varepsilon_X - 1}{\varepsilon_X}} + (1-a)^{\frac{1}{\varepsilon_X}} \left(X_{f,v}^H \right)^{\frac{\varepsilon_X - 1}{\varepsilon_X}} \right)^{\frac{\varepsilon_X}{\varepsilon_X - 1}} \tag{15}$$

where ε_X is the elasticity of substitution between foreign (superscript F) and home (H) variety of inputs and $a \geq 0$.

Each foreign (F) and domestic (H) input variety for firm f is given by a CES aggregator of sub-varieties, which are produced by foreign or domestic firms:

$$\begin{aligned} X_{f,v}^F &= \left(\sum_{k}^{N_{F,v}} \left(b_{f,vk}^F \right)^{\frac{1}{\varepsilon_F}} \left(x_{f,vk}^F \right)^{\frac{\varepsilon_F - 1}{\varepsilon_F}} \right)^{\frac{\varepsilon_F}{\varepsilon_F - 1}}, \\ X_{f,v}^H &= \left(\sum_{l}^{N_{H,v}} \left(b_{f,vl}^H \right)^{\frac{1}{\varepsilon_H}} \left(x_{f,vl}^H \right)^{\frac{\varepsilon_H - 1}{\varepsilon_H}} \right)^{\frac{\varepsilon_H}{\varepsilon_H - 1}} \end{aligned}$$

where $N_{F,v}$ and $N_{H,v}$ denote the number of foreign and domestic sub-varieties available for input variety v to firm f, respectively.[28] The elasticities of substitution among foreign and domestic inputs are respectively ε_F and ε_H with $b_{f,vk}^F \geq 0$ and $b_{f,vl}^H \geq 0$.

Firm's cost minimization leads to a constant marginal cost of production that is given by:

$$c_f = \frac{R^\alpha w^\beta \Pi_{v=1}^N \left(P_{f,v} \right)^{\gamma_v}}{A_f (\alpha)^\alpha (\beta)^\beta \Pi_{v=1}^N (\gamma_v)^{\gamma_v}} \tag{16}$$

where R is the cost of capital, w is the wage, and $P_{f,v}$ – the cost of the composite intermediate v (which is a function of domestic and foreign intermediate prices) – is defined by equation (27) in Appendix A. Firms are assumed to be perfectly competitive, and so the price that the firms charge will be equal to their marginal cost, $p_f = c_f$.[29]

[28]Note that the notation vk (vl) denotes a particular sub-variety of v of the foreign (home) kind.

[29]This simplifying assumption implies that firms in the model would not be able to change their markups as a response to a change in their costs.

6.1.2 Payment choice

When firms import, they choose between paying immediately and delaying payment (i.e., using international trade financing subjected to RUSF). By paying immediately, firm f incurs a financing cost, $r_f > 1$, say by borrowing from a domestic bank, but saves on the import tax $\tau_0 > 1$. Thus, the cost of importing variety k is equal to $r_f \times p^F_{f,vk}$, where $p^F_{f,vk}$ is the price of the imported variety excluding the cost of financing or taxes. If the firm delays payment by using the RUSF-subjected international trade financing, the cost becomes $\tau_0 \times p^F_{f,vk}$. The liquidity (short-term bank financing) costs, r_f, are drawn from a common and known distribution $g(r)$ with positive support on the interval $(\underline{r}, \infty)$ and a continuous cumulative distribution $G(r)$.

We assume that firms already agreed on the optimal types of payment terms for each imported intermediate through bargaining with their international suppliers *before the shock*. This gives rise to an exogenous firm distribution of exposure to the RUSF shock *at the time of the policy change*. For the ease of exposition, we assume that for a given composite intermediate vk, the firm chooses one payment method. We denote the set of composite intermediates for which firm f initially pays the tax on all foreign sub-varieties by N_τ.[30]

6.1.3 Effect of RUSF changes on firm costs

The increase in the RUSF rate from τ_0 to τ_1 leaves the exposed firms with a choice: for the next batch of goods to be imported, they can either switch to immediate payment or pay the increased tax. We assume that an immediate (i.e., cash in advance) payment for the imported good results in a cost of financing r_f for the firm, due to incremental debt (e.g., from a bank) that it has to incur for additional working capital to cover the associated costs. As a result, the firm compares its cost of liquidity (r_f) to its cost of international trade financing that is now subjected to the higher RUSF tax (τ_1), and chooses the least costly method. Given that firms are heterogeneous in the cost of liquidity they are facing, we can define a marginal firm that is indifferent between paying immediately and delaying payment: $r^* = \tau_1$. Firms with $r_f \in [\underline{r}, r^*]$ choose to pay immediately,

[30] The choice of optimal payment terms in international trade is determined by various factors related to the source and destination countries, the bargaining powers held by the foreign exporter and the Turkish importer, as well as the characteristics of the goods traded (Schmidt-Eisenlohr (2013); and Antràs and Foley (2015)). We are not modelling those factors explicitly in this paper. However, we do assume that the choice of international trade financing type doesn't affect the price of the imported good.

and others use international trade financing subjected to the higher tax to delay payment.

Consider a firm with $r_f > r^* = \tau_1$, i.e., a firm that is compelled to use RUSF-subjected foreign financing when sourcing input varieties v from abroad even after the shock for all $v \in N_\tau$ due to its high liquidity costs. The direct effect of a change in τ on the firm f's unit costs can be approximated by:

$$\frac{d \ln c_f}{d\tau} \Delta\tau = (\tau_1 - \tau_0) \sum_{v \in N_\tau} \gamma_v \frac{1}{\tau_0} \eta^F_{f,v} \tag{17}$$

where $\eta^F_{f,v}$ is the share of f's foreign intermediates in overall cost of input v.

The corresponding effect for a firm with a low liquidity cost $r_f < r^* = \tau_1$ is

$$(r_f - \tau_0) \sum_{v \in N_\tau} \gamma_v \frac{1}{\tau_0} \eta^F_{f,v} \tag{18}$$

In both expressions (17) and (18), the direct effect of a change in τ on firm f's unit (marginal) costs increases with the firm's exposure to international trade financing, which is represented by $\sum_{v \in N_\tau} \gamma_v \frac{1}{\tau_0} \eta^F_{fv}$. Also, for a given exposure, firms that have low costs of liquidity will experience a lower increase in their costs as $(\tau_1 - \tau_0) > (r_f - \tau_0)$.

The RUSF can also impact a firm's cost indirectly, through increases of firm suppliers' direct costs caused by the increase of this import levy. The exact expression is given in Appendix A.

6.1.4 Effect of RUSF on sales

Next, we analyze, in a simple network-production economy, the demand for a firm's output variety and the impact of a permanent change in an input cost on its sales.

Given its production function (14), firm f will spend a constant fraction γ_v of its input purchases on composite input v:

$$P_{f,v} X_{fv} = \gamma_v p_f Q_f \tag{19}$$

which can be re-written as

$$P_{f,v} X_{f,v} = p^H_{f,vl} x^H_{f,vl} \left(\eta^H_{f,v}\right)^{-1} \chi^{-1}_{f,vl}$$

where, $\eta^H_{f,v} = 1 - \eta^F_{f,v}$, is the share of domestic varieties in material inputs, whereas $\chi_{f,vl}$ is the share of the particular domestic sub-variety l of input v in the expenditures on domestic intermediates for composite input v, while $x^H_{f,vl}$ denote the quantity of home (H) input v's sub-variety l used in the production of firm f's (only) output, and $p^H_{f,vl}$ is its price.[31]

This set-up allows us to derive the demand for a particular home sub-variety as a function of prices, elasticities, productivities, and other parameters of the model.

Consider the demand for firm f product. Let Y denote global expenditure on domestic goods and final demand for domestic varieties be of the CES type $\left(\sum_l (\mu_l)^{\frac{1}{\varepsilon_Q}} (x_l)^{\frac{\varepsilon_Q - 1}{\varepsilon_Q}}\right)^{\frac{\varepsilon_Q}{\varepsilon_Q - 1}}$ with ε_Q being the elasticity of substitution in final demand and $\mu_l > 0$. In what follows, we set $\varepsilon_Q = \varepsilon_H$ to concentrate on the salient substitution across foreign and domestic varieties. Then, the final demand for an individual variety of firm f can be written as $x_f = (p_f)^{-1} \zeta_f Y$ where $\zeta_f = \frac{p_f x_f}{\sum_l p_l x_l}$ is the fraction of total final demand expenditures for the firm f's product. Assume that each firm's output is used as a sub-variety to produce only one type of composite inputs v. Then, the total demand for a firm's product coming from final demand and the demand from other $n-1$ firms can be written as:

$$Q_f = \frac{\zeta_f Y}{p_f} + \sum_{g \neq f}^{n} x_{gf} = \frac{\zeta_f Y}{p_f} + \sum_{g \neq f}^{n} \eta^H_{gv} \chi_{gvf} \frac{\gamma_v}{p_f} p_g Q_g$$

We can express the vector of firm sales $\mathbf{pQ} = [p_1 Q_1 \quad p_2 Q_2 \quad \dots \quad p_n Q_n]^T$ as

$$\mathbf{pQ} = (\mathbf{I} - \mathbf{\Xi})^{-1} \zeta Y, \tag{20}$$

where $\mathbf{\Xi}$ is a collection of constants as well as domestic intermediates' shares in the production process and the shares of particular varieties in firms' expenditures on domestic intermediates, both of which are endogenous. The term $(\mathbf{I} - \mathbf{\Xi})^{-1}$ in (20) summarizes all of the cross-effects that go through the economy.

To understand the effect of changes in the input cost (in our case, the increase in the RUSF levy on sales), let us consider a first-round approximation of firm f's sales based on the approximation of the inverse proposed by Waugh (1950). If firm f were to be the first firm, the sales are then

[31] We assume that the rest of the world is providing the inputs and/or Turkish firms are buying domestic inputs at exogenously given prices.

given by:

$$p_1 Q_1 = \begin{bmatrix} 1 & \eta^H_{2,v}\chi_{2,vf}\gamma_v & \ldots & \eta^H_{n,v}\chi_{n,vf}\gamma_v \end{bmatrix} \zeta Y.$$

This gives the direct effect of final (first entry) and indirect demands (rest of the vector) for the firm 1's product. Assuming that Y is constant (i.e., no demand shocks) and letting $p_f \equiv p^H_{gvf}$, the first-round effect of a change in the RUSF, operating through changes in firm's costs, on firm f's sales is given by:

$$\frac{\partial\left(p_f Q_f\right)}{\partial \tau} = Y\left(\sum_{g\neq f}\zeta_g\gamma_v\left[\eta^H_{gv}\frac{\partial \chi_{gvf}}{\partial p_f} + \chi_{gvf}\frac{\partial \eta^H_{gv}}{\partial p_f}\right] + \frac{\partial \zeta_f}{\partial p_f}\right)\frac{\partial p_f}{\partial \tau} \tag{21}$$

The effect above depends on the behavior of both the changes in the buyers' use of a particular intermediate among other domestic intermediates (i.e., $\frac{\partial \chi_{gvf}}{\partial p_f}\frac{\partial p_f}{\partial \tau}$), the general change in the usage of domestic and foreign intermediates (captured by the terms $\frac{\partial \eta^H_{gv}}{\partial p_f}\frac{\partial p_f}{\partial \tau}$), and the change in firm f's final demand $\frac{\partial \zeta_f}{\partial p_f}\frac{\partial p_f}{\partial \tau}$. As a result, the RUSF change can affect firm sales in complex ways. That said, we can separate out here the principal cost channels through which these changes should operate.

To consider the most plausible scenario, consider a situation where $\varepsilon_H > 1$ and $\varepsilon_X > 1$.[32] There is a negative effect on the firm's production costs due to the increase in the input prices (due to the RUSF levy). In the model, such cost increases are fully transmitted by the firms into their output prices (which is consistent with our results), $\frac{\partial \chi_{gvf}}{\partial p_f} < 0$ as firm f's buyers will substitute away from f's variety towards other domestic varieties (see equation (36) in the Appendix). Moreover, as this would increase the overall price level of domestic intermediates faced by buyer firms, there would be some substitution towards foreign intermediates, as $\frac{\partial \eta^H_{gv}}{\partial p_f} < 0$ (equation 37). Final demand for firms' f variety also falls as $\frac{\partial \zeta_f}{\partial p_f} < 0$. Finally, for a given level of reliance on international trade financing subject to RUSF, firms with high costs of bank credit (i.e., liquidity) would be subjected to a larger fall in sales because they would experience a higher increase in their costs. These observations are summarized in the following proposition.

[32] We are studying medium- and long-term effects of the shock (one to three years after impact). Hence, the substitution within domestic varieties (Broda and Weinstein (2006)) and between domestic and foreign inputs (see Imbs and Mejean (2015) or Feenstra, Luck, Obstfeld, and Russ (2018)) should be greater than 1.

Proposition 1 *Suppose $\varepsilon_H > 1$ and $\varepsilon_X > 1$. The impact of a RUSF change on firm's sales is negative for firms using international trade financing subject to the RUSF tax and, ceteris paribus, increasing:*

(i) *in the initial exposure of a firm to purchasing foreign intermediates with international trade financing that is subject to RUSF,*

(ii) *in the firm's liquidity costs, given the firm's initial exposure to international trade financing that is subjected to RUSF.*

Proof. See Appendix A. ∎

Another relevant cost channel operates through domestic suppliers that relied on the international trade financing that is subject to RUSF and were hit by the unexpected RUSF increase. As their imported-input costs go up due to RUSF increase, there is an increase in their total costs generating a passthrough to the buyer's costs, which in turn affects buyer's sales.[33] As a result, we can state the following:

Proposition 2 *Suppose that $\varepsilon_H > 1$ and $\varepsilon_X > 1$. The impact of a RUSF increase on firm's sales through domestic suppliers is negative and increasing in:*

(i) *the domestic input share,*

(ii) *imported input share of the firm's domestic suppliers, and*

(iii) *the share of domestic suppliers that face high liquidity costs, provided that at least some suppliers that are exposed to RUSF.*

Proof. See Appendix A. ∎

The effect on sales to buyers affected by RUSF (upstream propagation of the shock) would be close to zero if the substitution of demand towards domestic intermediates and the concomitant negative effect on sales balance out (see Section A.3.3 in the Appendix) even if technologies are not assumed to be Cobb-Douglas.

[33] Since the substitution between material inputs is not Cobb-Douglas, there could be also an effect on firms' sales coming from buyers (upstream propagation of the shock) that are exposed to the types of international trade financing subjected to RUSF. In particular, such buyers' own sales could be reduced (and hence rendering their input purchases lower), but at the same time they could substitute away from foreign to domestic intermediates, increasing their expenditures. Indeed, results presented in Table 3 suggest that this channel is not detectable.

6.2 Financial constraints and shock propagation

The simple model summarized in the previous subsection has clear predictions as to how firms will respond to the RUSF increase: (i) companies with no liquidity constraints will switch to cash-in-advance financing and avoid paying the higher RUSF import duty altogether, whereas (ii) liquidity-constrained firms will continue to rely on international trade financing that is subject to RUSF despite its higher cost after the shock. As a result liquidity-constrained firms will be more affected by the RUSF levy increase.

In our empirical setting, we define liquidity constrained firms relative to the mean liquidity measure for their industry (defined as one of the 22 two-digit-level NACE sectors) in the year prior to the shock. We measure ease of access to short-term financing with the average interest paid on existing debt calculated for 2010: total financing costs divided by existing debt stock, $FC_{f,t=2010}$.[34]

Figure A8 shows the distribution of the implied interest rate in the data. The average value of $FC_{f,t=2010}$ is 16%, which is about 6 percentage points above the average deposit rate in 2011. Based on the value of $FC_{f,t=2010}$, we split firms into two groups: constrained firms ($Constrained_{f,t=2010}$) have an implied interest rate that is above their two-digit-level NACE industry average; and unconstrained firms ($Unconstrained_{f,t=2010}$) have an implied interest rate below the mean.[35]

We augment our estimating equation (12) by adding the above-defined indicator variable for liquidity unconstrained firms ($Unconstrained_{f,t=2010}$), as well as its interaction with $\Delta\tau_f$.

[34] In the absence of firm-bank-level loan data, which would have given us the *marginal* cost of new bank credit for the firm as referred to in our theory model, we have to rely on the *average* cost of debt financing, albeit at the firm level. We reduce the measurement error associated with this *imputed* cost of debt (that we calculate using the firm's year-end $t = 2010$ financial statements) by classifying firms into high- and low-debt-financing cost groups in their industries. The underlying assumption is that, if firm f is among those with an average high cost of debt in its industry, the marginal bank credit it seeks in the face of the unexpected RUSF shock will have the same average, or possibly even higher, interest rate.

[35] The correlation between $\Delta\tau_f$ and $FC_{f,t=2010}$, conditional on industry and region fixed effects, is neither economically nor statistically significant. The result holds controlling for initial firm size and import intensity.

Table 4: **Role of Financial Constraints**

Dep var:	$\Delta_{11-12}\left(\frac{\text{Imports}}{\text{Total input purchases}}\right)_f$	$\Delta_{11-12}\left(\frac{\text{Total input purchases}}{\text{Total costs}}\right)_f$	$\left(\frac{\text{New suppliers in 2012}}{\text{Suppliers in 2010}}\right)_f$	$\Delta_{11-12}\ln Sales_f$
	(1)	(2)	(3)	(4)
$\Delta\ln\tau_f$	**-1.478*****	**1.759*****	**10.07***	**-9.107****
	(0.382)	(0.417)	(6.026)	(3.595)
$Unconstrained_{f,2010} * \Delta\ln\tau_f$	0.344	**-0.524***	**6.27***	**7.055***
	(0.470)	(0.288)	(9.738)	(4.031)
$\Delta\ln\tau_f^{Suppliers}$	-0.108	**1.771*****	-13.02	**-6.979***
	(0.112)	(0.618)	(10.36)	(3.565)
$\Delta\ln\tau_f^{Buyers}$	0.005	-0.001	0.773	-0.004
	(0.004)	(0.005)	(0.550)	(0.003)
R^2	0.0318	0.0336	0.0317	0.0266
N	54,968	54,968	54,968	54,968
Fixed effects	i-r	i-r	i-r	i-r
Firm-level controls	Yes	Yes	Yes	Yes

Notes: This table shows the results from estimating an extended version of the specification in equation (12) where the dependent variable changes across columns as follows. It is the annual change in the share of imports in total input purchases in column (1), annual change in the share of input purchases in total costs (where total costs are defined as input purchases and wages) in column (2), new domestic supplier links established in 2012 in column (3), and the growth rate of sales of firm f operating in industry i and located in region r in column (4). τ_f captures the firm-level effective tax rate, as defined in equation (2). $\tau_f^{Suppliers}$ and τ_f^{Buyers} are defined similarly in equations (7) and (8). $Unconstrained_{f,t=2010}$ is a dummy variable indicating liquidity-unconstrained firms, which have an implied interest rate on their existing debt below their 2-digit NACE industry average in 2010. All columns include $\ln \text{Employment}_{f,t=2010}$, i.e. the logarithm of the number of employees, and $\text{Import Intensity}_{f,2010}$, i.e. the share of imports in total costs of firm f in 2010, and $Unconstrained_{f,t=2010}$ as additional controls. The fixed effects are at the industry-region (ir) level. *, **, *** represent significance at the 10, 5, and 1 percent levels, respectively. Robust standard errors (in parentheses) are clustered at the industry-region level.

The results presented in Table 4 confirm our prediction that financial constraints, in the form of liquidity constraints, play a role in economic shocks' transmission. The estimates presented in the last column suggest that the impact of the shock on the sales growth of financially constrained firms is more than three times higher than its impact on financially unconstrained firms: assuming the price elasticity of demand $\varepsilon_H = 5$, the implied passthrough of tax onto prices is 2.3 for constrained firms compared to 0.5 for financially unconstrained firms. As for the other outcomes, the cost channel appears relevant here: estimates in column (2) suggest that financially constrained firms that were more exposed to the RUSF experienced a significantly higher increase in their input costs compared to financially unconstrained ones. Moreover, as presented in column (3), firms in the latter group were able to expand their domestic supplier network more extensively relative to the financially constrained ones within the same industry, which is presumably related to the ability to bear search costs.

We subject our results to two robustness tests. First, Table A8 presents the results from a robustness check that uses an alternative definition of short-term financial constraints, namely the quick ratio defined as the ratio of the sum of cash and marketable securities (i.e., cash equivalents) and accounts receivable to current liabilities. The results are similar to the ones presented in Table 4.[36] Second, we investigate whether allowing the pass-through rate to change with firm size affects our results.[37] To do so, we add an interaction between initial firm size and exposure to the RUSF shock to the baseline specification. As reported in Table A9, this modification strengthens our main result that financial constraints, in the form of liquidity constraints, play a role in economic shocks' transmission.

In our model, the RUSF shock affects firm prices similarly to a (negative) productivity shock. The first order effect of our relatively small, non-localized shock on real output of an exposed firm is approximated by the Hulten result and is equal to the ratio of the firm sales to GDP multiplied by the RUSF price elasticity (see Appendix A.3.4). The RUSF price elasticities differ depending on whether firms are liquidity constrained. The negative impact on real output of liquidity-constrained firms is, ceteris paribus, more than three times greater than that on output of unconstrained firms. Therefore, firms with financial constraints tend to amplify the shock's impact.

A similar conclusion follows when we study how shocks are transmitted by suppliers. In Table 5, we turn our attention to the potential role of liquidity constraints faced by the suppliers and buyers of the firm. To do so, we distinguish between the liquidity-constrained and -unconstrained suppliers as well as buyers when considering the indirect effects of the shock: we create two measures of indirect exposure via suppliers ($Exposure^{Suppliers,Uncons}_{f,t=2010}$, $Exposure^{Suppliers,Cons}_{f,t=2010}$) and do the same for buyers ($Exposure^{Buyers,Uncons}_{f,t=2010}$, $Exposure^{Buyers,Cons}_{f,t=2010}$).

[36] We choose the implied interest rate on existing debt as our baseline measure of financial constraints, as it better links our theoretical framework to the empirical results.

[37] In a recent paper, Amiti, Itskhoki, and Konings (2019) show that large firms have lower pass-through rates, and thus their sales respond less to changes in their costs.

Table 5: **Role of financial constraints: Direct and indirect effects**

Dep var:	$\Delta_{11-12}\left(\frac{\text{Imports}}{\text{Total input purchases}}\right)_f$	$\Delta_{11-12}\left(\frac{\text{Total input purchases}}{\text{Total costs}}\right)_f$	$\left(\frac{\text{New suppliers in 2012}}{\text{Suppliers in 2010}}\right)_f$	$\Delta_{11-12}\ln Sales_f$
	(1)	(2)	(3)	(4)
$\Delta\ln\tau_f$	**-1.278*****	**1.465*****	**19.39*****	**-5.345***
	(0.263)	(0.377)	(5.228)	(3.031)
$\Delta\ln\tau_f^{Suppliers,Cons}$	0.0865	**1.909***	-11.35	**-12.52***
	(0.177)	(1.059)	(12.38)	(6.774)
$\Delta\ln\tau_f^{Suppliers,Uncons}$	-0.138	1.159	-11.89	-5.950
	(0.130)	(0.753)	(13.20)	(4.141)
$\Delta\ln\tau_f^{Buyers,Cons}$	-0.0204	0.00383	0.0111	0.00101
	(0.0125)	(0.0633)	(0.00760)	(0.00312)
$\Delta\ln\tau_f^{Buyers,Uncons}$	-0.0123	-0.00111	-0.00521	0.00195
	(0.0106)	(0.0803)	(0.00663)	(0.00354)
R^2	0.0318	0.0337	0.0317	0.0294
$\Delta\ln\tau_f$	**-1.277*****	**1.461*****	**19.40*****	**-6.429****
	(0.263)	(0.376)	(5.222)	(2.917)
$\Delta\ln\tau_f^{Suppliers,Cons}$	-0.0295	**2.520****	-13.79	**-11.44****
	(0.179)	(1.027)	(11.00)	(5.799)
$\Delta\ln\tau_f^{Suppliers,Uncons}$	-0.159	**1.301***	-12.34	-4.179
	(0.130)	(0.750)	(13.05)	(4.091)
$\Delta\ln\tau_f^{Buyers,Cons}$	0.008	-0.008	0.010	0.0047
	(0.011)	(0.040)	(0.007)	(0.0038)
$\Delta\ln\tau_f^{Buyers,Uncons}$	-0.010	-0.002	-0.010	0.0078
	(0.041)	(0.062)	(0.003)	(0.0025)
$\Delta\ln\tau_f^{Suppliers,SizeWeighted}$	-0.00329	0.0213***	-0.0676	-0.0900*
	(0.0031)	(0.0066)	(0.105)	(0.0471)
$\Delta\ln\tau_f^{Buyers,SizeWeighted}$	0.0028	-0.0130	-0.0289	-0.183***
	(0.0025)	(0.0108)	(0.116)	(0.066)
R^2	0.0318	0.0337	0.0317	0.0294
N	54,968	54,968	54,968	54,968
Fixed effects	i-r	i-r	i-r	i-r
Firm-level controls	Yes	Yes	Yes	Yes

Notes: This table shows the results from estimating an extended version of the specification in equation (12) where the dependent variable changes across columns as follows. It is the annual change in the share of imports in total input purchases in column (1), annual change in the share of input purchases in total costs (where total costs are defined as input purchases and wages) in column (2), new domestic supplier links established in 2012 in column (3), and the growth rate of sales of firm f operating in industry i and located in region r in column (4). τ_f captures the firm-level effective tax rate, as defined in equation (2). $\tau_f^{Suppliers}$ and τ_f^{Buyers} are defined similarly in equations (7) and (8). $\tau_f^{Suppliers,Uncons}$ ($\tau_f^{Buyers,Uncons}$) denotes the weighted average of liquidity-unconstrained suppliers' (buyers') effective tax rate (i.e. suppliers (buyers) with the implied interest rate on existing debt below the industry mean as of $t = 2010$) of firm f. $\tau_f^{Suppliers,Cons}$ ($\tau_f^{Buyers,Cons}$) denotes the weighted average of liquidity-constrained suppliers' (buyers') effective tax rate (i.e. suppliers (buyers) with the implied interest rate on existing debt below the industry mean as of $t = 2010$) of firm f. The last two variables in the table are defined as follows: $\Delta\tau_f^{Suppliers,SizeWeighted} = \sum_s \omega_{fs,t=2010} \times \ln \overline{Employment}_{s,t=2010}$ where $\omega^S_{fs,t=2010}$ is the share of supplier s in firm f's total variable costs in year 2010; and $\overline{Employment}_{s,t=2010}$ is supplier s's employment relative to its industry average as of 2010. Similarly, $\Delta\tau_f^{Buyers,SizeWeighted} = \sum_s \omega^B_{fb,t=2010} \times \ln \overline{Employment}_{b,t=2010}$, where $\omega^B_{fb,t=2010}$ is the share of buyer b in firm f's total sales in year 2010, and $\overline{Employment}_{b,t=2010}$ is buyer b's employment relative to its industry average as of 2010. All columns include $\ln \text{Employment}_{f,t=2010}$, i.e. the logarithm of the number of employees, and Import $\text{Intensity}_{f,2010}$, i.e. the share of imports in total costs of firm f in 2010 as additional controls. The fixed effects are at the industry-region (ir) level. *, **, *** represent significance at the 10, 5, and 1 percent levels, respectively. Robust standard errors (in parentheses) are clustered at the industry-region level.

The results presented in the top panel of Table 5 suggest that the indirect effects are due only to financially constrained suppliers. The statistically significant coefficients on financially-constrained suppliers found in columns (2) and (4) indicate that their role in shock propagation is visible in the affected firms' input cost share and sales. In contrast, none of the coefficients on financially-unconstrained suppliers reaches conventional significance levels. We also note that previously observed lack of evidence for buyers continues to prevail when we account for liquidity constraints: we observe no statistically discernible effect for financially-constrained buyers.

To double check that we are really capturing the impact of suppliers' financial constraints rather than the effects of an omitted variable correlated with size (since access to finance is easier for larger firms), we include two additional variables in our regression specification: the size-weighted average exposures of the firm to its suppliers and buyers as of the year 2010.[38] The results presented in the bottom panel Table 5 confirm our earlier findings. They suggest that the indirect effect is much larger for firm's cost of input purchases and sales when it comes from financially constrained suppliers. In column (4) of Table 5, where the dependent variable is sales growth, the coefficient estimate for $Exposure^{Suppliers,Cons}_{f,t=2010}$ is equal to -11.4, whereas the one for $Exposure^{Suppliers,Uncons}_{f,t=2010}$ is equal to -4.2, with only the former being statistically significant at the conventional levels. The difference between the two effects is statistically significant as well.

Summarizing, the results in this subsection support the theoretical predictions of our simple theory framework. They are also consistent with the view that liquidity-constrained firms magnify and propagate the perturbation downstream.

7 Conclusions

This paper examines whether a relatively small and non-localized cost-push shock propagates in a production chain, and if it does, what are its short- and medium-run effects on the firms in the network. Such socks are typically difficult to discern clearly in the data. To identify the effects of the supply shock, we use an unexpected policy change in Turkey that increased the price of imports from 3% to 6% overnight. Given that this tax is based on the type of international trade financing

[38]These variables are defined as follows: $\Delta\tau_f^{Suppliers,SizeWeighted} = \sum_s \omega_{fs,t=2010} \times \ln \overline{Employment}_{s,t=2010}$ where $\omega^S_{fs,t=2010}$ is the share of supplier s in firm f's total variable costs in year 2010; and $\overline{Employment}_{s,t=2010}$ is supplier s's employment relative to its industry average as of 2010. Similarly, we define $\Delta\tau_f^{Buyers,SizeWeighted} = \sum_s \omega^B_{fb,t=2010} \times \ln \overline{Employment}_{b,t=2010}$, where $\omega^B_{fb,t=2010}$ is the share of buyer b in firm f's total sales in year 2010, and $\overline{Employment}_{b,t=2010}$ is buyer b's employment relative to its industry average as of 2010.

used, the policy change had a heterogeneous impact across importers, a feature that we exploit for identifying the impact of the cost-shock.

The results, based on detailed Turkish production network data, can be summarized as follows. First, we find that what is a priori a fairly benign policy change on imports has an economically relevant, even if temporary, impact on the directly-exposed firms' performance. Second, the shock leads to changes in the affected-firms' sourcing patterns: our analysis shows that directly exposed firms switch to local suppliers. Moreover, this switch is not limited to the short term, as it takes place over three years after the policy change. Third, the input-shock propagates downstream as exposed suppliers pass it onto their customers. More interestingly, indirect exposure through suppliers magnifies the effects of the tax increase over and above the effects of the firms' direct exposure. Fourth, propagation of the cost-push shock is amplified by liquidity-constrained firms.

Put differently, our findings suggest that even relatively minor and non-localized economic shocks can affect open economies in ways that are non-negligible as they are transmitted over the production networks. The resulting impact is not limited to direct exposure only: indirect exposure through suppliers appears to be equally important in terms of economic magnitudes. Importantly, the relatively small shock that we consider changes the exposed firms' supplier networks: the affected firms switch from imported varieties to their domestic counterparts. The resulting effects on firm performance appear to be level effects, with the exception of the changes to exposed firms' supplier networks, which take place over a longer time period. A likely explanation is that the search costs involved in finding new suppliers: the observed changes in the supplier networks suggest that such costs are not economically trivial even in a domestic setting. We believe that quantifying the explicit and implicit search costs for substitute products and suppliers, which we do not undertake here, is worthy of further research.

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A Conceptual Framework

In this section, we provide a more detailed derivation of the model introduced in Section 6.1.

A.1 Firms, production and cost minimization

Assume a fixed number of firms n, indexed by f, which combine labor, capital, and intermediate inputs to produce a distinct variety according to the following production function:

$$Q_f = A_f K_f^{\alpha} L_f^{\beta} \Pi_{v=1}^{N} X_{fv}^{\gamma_v} \tag{22}$$

where, A_f is firm-specific productivity shifter; K_f denotes capital input, L_f labor, X_{fv} is the composite input v used by firm f (equation 23). We assume $\alpha + \beta + \sum \gamma_v = 1$, i.e. a constant returns to scale technology. Each firm minimizes its production costs, taking the input prices as given. Each composite input v is represented as a CES aggregate of domestic and imported material inputs:

$$X_{fv} = \left(a^{\frac{1}{\varepsilon_X}} \left(X_{fv}^F \right)^{\frac{\varepsilon_X - 1}{\varepsilon_X}} + (1-a)^{\frac{1}{\varepsilon_X}} \left(X_{fv}^H \right)^{\frac{\varepsilon_X - 1}{\varepsilon_X}} \right)^{\frac{\varepsilon_X}{\varepsilon_X - 1}} \tag{23}$$

where ε_X is the elasticity of substitution between foreign (superscript F) and home (H) material inputs and $a \geq 0$.

Each foreign and domestic variety is given by a CES aggregator of sub-varieties, which are produced by foreign or domestic firms:

$$\begin{aligned} X_{fv}^F &= \left(\sum_k^{N_{fv}} \left(b_{fvk}^F \right)^{\frac{1}{\varepsilon_F}} \left(x_{fvk}^F \right)^{\frac{\varepsilon_F - 1}{\varepsilon_F}} \right)^{\frac{\varepsilon_F}{\varepsilon_F - 1}} \\ X_{fv}^H &= \left(\sum_l^{N_{H,v}} \left(b_{fvl}^H \right)^{\frac{1}{\varepsilon_H}} \left(x_{fvl}^H \right)^{\frac{\varepsilon_H - 1}{\varepsilon_H}} \right)^{\frac{\varepsilon_H}{\varepsilon_H - 1}} \end{aligned}$$

where, N_{fv} and $N_{H,v}$ denote the number of foreign and domestic sub-varieties available for input v to firm f, respectively. The elasticities of substitution among foreign and domestic inputs are respectively ε_F and ε_H with $b_{fvk}^F \geq 0$ and $b_{fvl}^F \geq 0$ being parameters.

The price indices for foreign and domestic varieties associated with input variety v as:

$$\begin{aligned}
\widetilde{P}^{F}_{fv} &= \sum_{k}^{N_{fv}} \left(p^{F}_{fvk}\right)^{1-\varepsilon_F} b^{F}_{fvk} \qquad (24)\\
\widetilde{P}^{H}_{fv} &= \sum_{l}^{N_{H,v}} \left(p^{H}_{fvl}\right)^{1-\varepsilon_H} b^{H}_{fvl}
\end{aligned}$$

Cost minimization implies the following firm's expenditures on foreign and domestic varieties:

$$\begin{aligned}
\sum_{k}^{N_{fv}} p^{F}_{fvk} x^{F}_{fvk} &= \left(\widetilde{P}^{F}_{fv}\right)^{-\frac{1}{\varepsilon_F - 1}} X^{F}_{fv} \qquad (25)\\
\sum_{l}^{N_{H,v}} p^{H}_{fvl} x^{H}_{fvl} &= \left(\widetilde{P}^{H}_{fv}\right)^{-\frac{1}{\varepsilon_H - 1}} X^{H}_{fv}
\end{aligned}$$

Firms' cost minimization leads to a constant marginal cost of production that is given by:

$$c_f = \frac{R^{\alpha} w^{\beta} \Pi_{v=1}^{N} \left(P_{fv}\right)^{\gamma_v}}{A_f \left(\alpha\right)^{\alpha} \left(\beta\right)^{\beta} \Pi_{v=1}^{N} \left(\gamma_v\right)^{\gamma_v}}, \qquad (26)$$

where R is the cost of capital, w is the wage and P_{fv} the cost of the composite intermediate:

$$P_{fv} = \left(a \left(\widetilde{P}^{F}_{fv}\right)^{\frac{\varepsilon_X - 1}{\varepsilon_F - 1}} + (1-a) \left(\widetilde{P}^{H}_{fv}\right)^{\frac{\varepsilon_X - 1}{\varepsilon_H - 1}}\right)^{\frac{1}{1-\varepsilon_X}}. \qquad (27)$$

Firms are assumed to be perfectly competitive, and so the price that the firms charge will be equal to their marginal cost, $p_f = c_f$.

A.2 Incorporating payment choice

When firms import, they choose between paying immediately and delaying payment. By paying immediately, firm f incurs a financing cost, $r_f > 1$ but saves on the import tax $\tau_0 > 1$. Thus, the cost of importing sub-variety k to produce variety v is equal to $r_f \times p^{F}_{fvk}$, where p^{F}_{fvk} is the price of the imported variety excluding the cost of financing or taxes. If the firm delays payment by using (RUSF-subjected) international trade financing, the cost becomes $\tau_0 \times p^{F}_{fvk}$. The liquidity costs, r_f, are drawn from a common and known distribution $g(r)$ with positive support on the interval

$(\underline{r}, \infty)$ and a continuous cumulative distribution $G(r)$.

We assume that firms already agreed on the optimal types of payment terms for each imported intermediate through bargaining with their international suppliers *before the shock* (i.e., at $t =$ 2010). This gives rise to an exogenous firm distribution of exposure to the RUSF shock *at the time of the policy change* (i.e., at $t = 0$). For ease of exposition, we assume that for a given composite intermediate, the firm chooses one payment method. We denote the set of composite intermediates for which firm f initially pays the tax on all foreign sub-varieties by N_τ.

A.2.1 Effect of RUSF changes on firm costs

The increase in the RUSF rate from τ_0 to τ_1 leaves the exposed firms with a choice: for the next batch of goods to be imported, they can either switch to immediate payment or pay the increased tax. We assume that immediate (i.e., cash in advance) payment for the imported good results in a cost of financing r_f for the firm, for example, due to additional bank debt it has to incur. As a result, the firm compares its cost of liquidity (r_f) to its cost of international trade financing that is now subjected to the higher RUSF tax (τ_1), and chooses the method that is lower. Given that firms are heterogeneous in the cost of liquidity they are facing, we can define a marginal firm that is indifferent between paying immediately and delaying payment: $r^* = \tau_1$. Firms with $r_f \in [\underline{r}, r^*]$ choose to pay immediately, and others use international trade financing subjected to the higher tax to delay payment.

Taking the logarithm of both sides of (26) and letting Γ be a collection of parameters, we obtain:

$$\ln c_f = \alpha \ln R + \beta \ln w + \sum_{v=1}^{N} \gamma_v P_{fv} - \ln A_f - \Gamma.$$

Now, consider a firm with $r_f > r^* = \tau_1$, i.e., a firm that uses external financing when sourcing inputs from abroad even after the shock for $j \in N_\tau$. The *direct* effect of a change in τ on the firm's unit costs, going through the imported input prices P_{fv} is (approximately):

$$\frac{d \ln c_f}{d\tau} \Delta\tau = (\tau_1 - \tau_0) \sum_{v \in N_\tau} \gamma_v \frac{1}{\tau_0} \eta_{fv}^F \tag{28}$$

where $\eta^F_{fv} = \frac{a\left(\widetilde{P}^F_{fv}\right)^{\frac{1-\varepsilon_X}{1-\varepsilon_F}}}{\left(a\left(\widetilde{P}^F_{fv}\right)^{\frac{1-\varepsilon_X}{1-\varepsilon_F}}+(1-a)\left(\widetilde{P}^H_{fv}\right)^{\frac{1-\varepsilon_X}{1-\varepsilon_H}}\right)}$ is the share of foreign intermediates in the overall cost of input v for firm f.

The corresponding effect for a firm with $r_f < r^* = \tau_1$ is

$$(r_f - \tau_0) \sum_{v \in N_\tau} \gamma_v \frac{1}{\tau_0} \eta^F_{fv}. \tag{29}$$

In both expressions (28) and (29), the direct effect of a change in τ on firm f's unit (marginal) costs increases with the firm's exposure to external financing, which is represented by the summation $\sum_{v \in N_\tau} \gamma_v \frac{1}{\tau_0} \eta_{fv}$. Also, for a given exposure, firms that have low costs of liquidity will experience a lower increase in their costs as $(\tau_1 - \tau_0) > (r_f - \tau_0)$.

In the model, firms are affected by the change in the tax rate τ through two channels. First, a rise in the RUSF affects firms directly by increasing the cost of imported inputs. Second, the rise in RUSF increases costs faced by firms' domestic suppliers, which affects downstream firms' costs to the extent that the suppliers pass these increases onto their buyers. It is precisely through the latter channel how non-importers can be affected through the change in the RUSF tax. Firm's f price index for input j depends indirectly on τ through the impact of RUSF on the price of domestically purchased varieties as follows:

$$\left(\frac{\partial \ln P_{fv}}{\partial \tau}\right)_{indirect} = \frac{1}{1-\varepsilon_H} \eta^H_{fv} \frac{\frac{\partial \widetilde{P}^H_{fv}}{\partial \tau}}{\widetilde{P}^H_{fv}} \tag{30}$$

where $\eta^H_{fv} = 1 - \eta^F_{fv}$ is the share of domestic intermediates in the cost of input v for firm f and

$$\frac{\partial \widetilde{P}^H_{fv}}{\partial \tau} = \frac{\partial \left(\sum_l^{N_{H,v}} \left(p^H_{fvl}\right)^{1-\varepsilon_H} b^H_{fvl}\right)}{\partial \tau} = (1-\varepsilon_H)\left[\sum_l^{N_{H,v}} b^H_{fvl} \left(p^H_{fvl}\right)^{(-\varepsilon_H)} \frac{\partial \left(p^H_{fvl}\right)}{\partial \tau}\right].$$

In our simple framework, firms do not charge mark-ups, and any changes in their costs are reflected in their prices so that $\frac{\partial p^H_{fvl}}{\partial \tau} = \frac{\partial c_{fvl}}{\partial \tau}$. The direct cost increase of each of the suppliers depends on their use of foreign intermediates and their liquidity cost, and these changes will be given by expressions similar to equations (28) and (29).

Combining all above elements into equation (30), assuming that secondary and further network effects (effects through suppliers of suppliers and so on) are negligible, the indirect change in the cost of firm f caused by a change in the RUSF is given by:

$$\sum_{v=1}^{N}\gamma_v\frac{1}{\tau_0}\eta_{fv}^{H}\left\{\begin{array}{c}\left[(\tau_1-\tau_0)\sum_{l\notin\Theta_{fv}}\chi_{fvl}\left(\sum_{q\in N_{\tau,l}}\gamma_q\eta_{lq}^{F}\right)\right]\\+\left[\sum_{l\in\Theta_{fv}}(r_l-\tau_0)\,\chi_{fvl}\left(\sum_{q\in N_{\tau,l}}\gamma_q\eta_{lq}^{F}\right)\right]\end{array}\right\} \tag{31}$$

where Θ_{fv} denotes, for firm f and input variety v, the set of suppliers that face low liquidity costs, i.e., $r_f < r*$, and $\chi_{fvl} = \frac{p_{fvl}^{H}x_{fvl}^{H}}{\sum p_{fvk}^{H}x_{fvk}^{H}} = \frac{b_{fvl}^{H}\left(p_{fvl}^{H}\right)^{1-\varepsilon_H}}{\widetilde{P}_{fv}^{H}}$, the share of domestic sub-variety l in the expenditures on all domestic varieties in the composite input v.

For firm f, the indirect effect of changes in τ on firm's f cost is increasing in the domestic input share of firm f, the imported input share of the firm's domestic suppliers, and the number of domestic suppliers that face high liquidity costs.

A.3 The effect of RUSF on sales

Given the production function (22) for firm f, the firm will spend a constant fraction of its input expenditures on input v:

$$P_{fv}X_{fv} = \gamma_v p_f Q_f, \tag{32}$$

which can be re-written as

$$P_{fv}X_{fv} = p_{fvl}^{H}x_{fvl}^{H}\left(\eta_{fv}^{H}\right)^{-1}\chi_{fvl}^{-1},$$

where $\chi_{fvl} = \frac{\left(p_{fvl}^{H}\right)^{1-\varepsilon_H}b_{fvl}^{H}}{\sum\left(p_{fvk}^{H}\right)^{1-\varepsilon_H}b_{fvk}^{H}} = \frac{p_{fvl}^{H}x_{fvl}^{H}}{\sum p_{fvk}^{H}x_{fvk}^{H}}$ is the share of the particular domestic variety l in the expenditures on domestic intermediates.

The rest of the world is providing inputs and/or buying domestic products at exogenously given prices. Let Y denote global expenditure on domestic goods and final demand for domestic varieties be of the CES type $\left(\sum_l(\mu_l)^{\frac{1}{\varepsilon_Q}}(x_l)^{\frac{\varepsilon_Q-1}{\varepsilon_Q}}\right)^{\frac{\varepsilon_Q}{\varepsilon_Q-1}}$ with ε_Q being the elasticity of substitution in final demand. In what follows, we shall set $\varepsilon_Q = \varepsilon_H$. Then, the final demand for an individual variety of firm f can be written as $x_f = (p_f)^{-1}\zeta_f Y$ where $\zeta_f = \frac{p_f x_f}{\sum_l p_l x_l}$ is the fraction of total final demand expenditures for the firm f's product. Assume that each firms' output is used as a sub-variety to produce only one type of composite inputs v. Then, the total demand for a firm's product coming from final demand and the demand from other $n-1$ firms can be written as:

$$Q_f = \frac{\zeta_f Y}{p_f} + \sum_{g \neq f}^{n} x_{gf} = \frac{\zeta_f Y}{p_f} + \sum_{g \neq f}^{n} \eta_{gv}^{H} \chi_{gvf} \frac{\gamma_v}{p_f} p_g Q_g$$

Let us define $\xi_{fg} = \eta_{gv}^{H} \chi_{gvf} \gamma_v$ and $\xi_{f,f} = 0$; $\xi_f = \begin{bmatrix} \xi_{f,1} & \xi_{f,2} & \dots & \xi_{f,n} \end{bmatrix}$; and $\mathbf{pQ} = \begin{bmatrix} p_1 Q_1 & p_2 Q_2 & \dots & p_n Q_n \end{bmatrix}^T$. Then we can write

$$p_f Q_f = \zeta_f Y + \xi_f \mathbf{pQ}$$

Stacking for all firms, with $\boldsymbol{\Xi} = \begin{bmatrix} \xi_1 & \xi_2 & \dots & \xi_n \end{bmatrix}^T$ and $\zeta = \begin{bmatrix} \zeta_1 & \zeta_2 & \dots & \zeta_n \end{bmatrix}^T$, we obtain

$$\mathbf{pQ} = (\mathbf{I} - \boldsymbol{\Xi})^{-1} \zeta Y, \tag{33}$$

where $\boldsymbol{\Xi}$ is a collection of constants as well as domestic intermediates shares in the production process and the shares of particular varieties of firms' expenditures on domestic intermediates, both of which are endogenous. The term $(\mathbf{I} - \boldsymbol{\Xi})^{-1}$ in (33) is the Leontief's inverse that summarizes all the effects that go through the economy.

To understand the effect of changes in the RUSF levy on sales, let us consider only the first-round effects – an approximation proposed by Waugh (1950). If firm f was the first firm:

$$p_1 Q_1 = \begin{bmatrix} 1 & \eta_{2,v}^{H} \chi_{2,v,f} \gamma_v & \dots & \eta_{n,v}^{H} \chi_{n,v,f} \gamma_v \end{bmatrix} \zeta Y \tag{34}$$

This gives the direct effect of final consumer (first entry) and firm input demands (rest of the vector) for the firm's product. Concentrating on first-order effects, the first-round effect of a change in τ on firm f sales, letting $p_f \equiv p_{gvf}^{H}$, is given by:

$$\frac{\partial (p_f Q_f)}{\partial \tau} = Y \left(\sum_{g \neq f} \zeta_g \gamma_v \left[\eta_{gv}^{H} \frac{\partial \chi_{gvf}}{\partial p_f} + \chi_{gvf} \frac{\partial \eta_{gv}^{H}}{\partial p_f} \right] + \frac{\partial \zeta_f}{\partial p_f} \right) \frac{\partial p_f}{\partial \tau} \tag{35}$$

The effect depends on the behavior of both the changes in the usage by buyers of a particular intermediate among other domestic intermediates (the first term) $\frac{\partial \chi_{gvf}}{\partial p_f}\frac{\partial p_f}{\partial \tau}$ and their general change in the usage of domestic intermediates captured by the terms $\frac{\partial \eta^H_{gv}}{\partial p_f}\frac{\partial p_f}{\partial \tau}$. Their overall impact depends, inter alia, on the change in the share of domestic inputs usage in the composite inputs across all firms in the economy. There is also a first order effect on the final demand for firm f's variety $\frac{\partial \zeta_f}{\partial p_f}\frac{\partial p_f}{\partial \tau}$.

A.3.1 Direct effects of RUSF on firm sales

Proof of Proposition 1

From equation (21) one can derive the impact of RUSF on firm f sales through a direct increase of the firm's marginal cost.

From the perspective of firm g purchasing a from firm f to produce the composite input v,

$$\frac{\partial \chi_{gvf}}{\partial p^H_{gvf}} = \frac{(1-\varepsilon_H)}{p^H_{gvf}}\chi_{gvf} \tag{36}$$

$$\frac{\partial \eta^H_{gv}}{\partial p^H_{gvf}} = \frac{(1-\varepsilon_X)}{p^H_{gvf}}\eta^H_{gv}\eta^F_{gv}\chi_{gvf} \tag{37}$$

For ζ_f small,

$$\frac{\partial \zeta_f}{\partial \tau} \approx (1-\varepsilon_H)\frac{\partial p_f}{\partial \tau}(p_f)^{-1}\zeta_f. \tag{38}$$

Combining (36) – (38) with expressions for the change in the marginal cost equation (21) and ignoring the effects on final demand of other goods we obtain:

$$\Delta F\frac{\partial (p_f Q_f)}{\partial \tau} \approx \Delta F(1-\varepsilon_H)Y\left(\sum_{\nu\in N_\tau}\frac{\gamma_\nu}{\tau_0}\eta^F_{f\nu}\right)\left(\sum_{g\neq f}\zeta_g\gamma_v\eta^H_{gv}\chi_{gvf}\left[1+\frac{(1-\varepsilon_X)}{(1-\varepsilon_H)}\eta^F_{gv}\chi_{gvf}\right]+\zeta_f\right) \tag{39}$$

where $\Delta F = (\tau_1 - \tau_0)$ for a liquidity constrained and $\Delta F = (r_f - \tau_0)$ for a liquidity unconstrained $(r_f < \tau_1)$ that was using external financing. If $\varepsilon_H > 1$ and $\varepsilon_X > 1$ then the effects of a direct RUSF cost-push shock on firm f sales are negative. The impact is higher for firms with a greater exposure to intermediates imported on credit terms (claim i) and for firms with higher liquidity costs (claim ii), as their cost increase is greater. *Q.E.D.*

One can rewrite equation (39) as the elasticity of sales with respect to the tax separating it into (i) the elasticity of price with respect to tax ($\frac{\partial p_f}{\partial \tau}\frac{\tau}{p_f}$), and (ii) the price elasticity of demand for domestic varieties $(1-\varepsilon_H)$, noting that empirically in our data on average $\eta_{gv}^F \chi_{gvf}$ and ζ_f are small.

$$\frac{\partial \left(p_f Q_f\right)}{\partial \tau}\frac{\tau}{p_f Q_f} \approx \left(1-\varepsilon_H\right)\frac{\partial p_f}{\partial \tau}\frac{\tau}{p_f} \tag{40}$$

A.3.2 Effects of RUSF through suppliers' costs

Proof of Proposition 2

Given the derivations in Section A.3.1 – equations (36) and (37) – it is straightforward to obtain the changes in firm f costs stemming from the RUSF cost of suppliers and substitute for $\frac{\partial p_f}{\partial \tau}$ from equation (31). It is immediate that the impact of changes in τ through supplier's costs on the cost of composite input j and then on total cost and sales of firm f is increasing in the domestic input share of firm f, η_{fv}^H (claim i); the imported input share of the firm's domestic suppliers (claim ii), and the number of domestic suppliers that face high liquidity costs (claim iii). *Q.E.D.*

A.3.3 Effects of RUSF through buyer's demand

A buyer that is struck by a RUSF shock will substitute away from foreign to domestic suppliers; but if this increases their costs this has a negative impact on their sales. Indirectly, then, it will affect the demand for the domestic suppliers as well. These contradicting forces can be seen in the changes in firm 2 input demand from firm 1 in eq. (34) after a RUSF shock hits firm 2. Since $\frac{\partial \chi_{fji}}{\partial \tau_f} = 0$ because own RUSF shock does not affect the choice within domestic intermediates, we find

$$\frac{\partial \left(p_1 Q_1\right)}{\partial \tau_2} \approx \left[-\left(1-\varepsilon_X\right)\eta_{2j} + \left(1-\varepsilon_Q\right)\sum_{k\in N_2}\gamma_k \eta_{2k}\right]\frac{1}{\tau_0}\left(1-\eta_{2j}\right)\chi_{2ji}\gamma_j\zeta_2 Y$$

and the resulting elasticity is $\frac{\partial S_1}{\partial \tau}\frac{\tau_0}{S_1} = \left[-\left(1-\varepsilon_X\right)\eta_{2j}^F + \left(1-\varepsilon_Q\right)\sum_{k\in N_m}\gamma_k \eta_{2k}^F\right]$. If $\varepsilon_X = \varepsilon_Q = 1$ the technologies are Cobb-Douglas, both the impact of RUSF on substitution between foreign and domestic varieties and on sales are zero. But the opposing effects between the substitution towards domestic varieties and the fall in sales on firm 2 demand for domestic intermediates may also cause the net effect to be zero if $\varepsilon_X \neq 1$ and $\varepsilon_Q \neq 1$. Suppose that the share of foreign varieties in the production of composite varieties is equal: $\eta^F_{2j} = \eta^F_{2k}$ for any $j, k \in \{1, ..., N_m\}$. Then if $(1-\varepsilon_X) = (1-\varepsilon_Q)\sum_{k \in N_m} \gamma_k$, upstream propagation will be zero as well. Given our production function $\sum_{k \in N_m} \gamma_k = 1 - \alpha - \beta < 1$. This means that for a wide range of reasonable parameter values upstream propagation will be small or close to zero. For example, if $\varepsilon_X = 2$ and $\varepsilon_Q = 6$, and $\sum_{k \in N_m} \gamma_k \approx \frac{1}{3}$.

A.3.4 First order effects of a firm-level RUSF shock on real output

Our constant-returns to scale final demand aggregator - measure of real aggregate output is

$$U = \max_{x_l} \left(\sum_l (\mu_l)^{\frac{1}{\varepsilon_Q}} (x_l)^{\frac{\varepsilon_Q - 1}{\varepsilon_Q}} \right)^{\frac{\varepsilon_Q}{\varepsilon_Q - 1}}$$

subject to the budget constraint $\sum p_l c_l = \overline{Y}$ where $\overline{Y}$ is expenditures or nominal GDP. We show that

$$\frac{d \ln U}{d \ln \tau_i} = -\lambda_i \varphi_i$$

where $\lambda_i = \frac{p_i y_i}{\overline{Y}} = (\mathbf{I} - \mathbf{\Xi}_i)^{-1} \zeta$ is firm's i Domar share.

Let $\ln U = g(x_1, x_2, ..., x_l)$. Then

$$\frac{d \ln U}{d \ln \tau_i} = \sum_l \frac{\partial g}{\partial x_l} \tau_i \frac{d x_l}{d \tau_i}$$

where $\frac{\partial g}{\partial x_i} = \frac{\zeta_i}{x_i}$ from properties of the CES demand. Since here $x_i = \frac{\zeta_i}{p_i} \bar{Y}$, $\frac{dx_i}{d\tau_i} = \bar{Y}\left[\frac{1}{p_i}\frac{d\zeta_i}{d\tau_i} - \frac{\zeta_i}{p_i^2}\frac{\partial p_i}{\partial \tau_i}\right]$, and $\frac{\partial \zeta_i}{\partial \tau_i} = \frac{\partial \zeta_i}{\partial p_i}\frac{\partial p_i}{\partial \tau_i} = (1-\zeta_i)\zeta_i \frac{(1-\varepsilon_Q)}{p_i}\frac{\partial p_i}{\partial \tau_i}$,

$$\frac{dx_i}{d\tau_i} = x_i \left[(1-\zeta_i)(1-\varepsilon_Q) - 1\right] \frac{\varphi_i}{\tau_i}$$

where $\varphi_i = \frac{\tau_i}{p_i}\frac{\partial p_i}{\partial \tau_i}$ is the firm i price elasticity with respect to the RUSF tax. The change in the final demand for other goods is given by $\frac{dx_f}{d\tau_i} = \bar{Y}\left[\frac{1}{p_f}\frac{\partial \zeta_f}{\partial \tau_i} - \frac{\zeta_f}{p_f^2}\frac{\partial p_f}{\partial \tau_i}\right]$. As $\frac{\partial \zeta_f}{\partial \tau_i} = \frac{\partial \zeta_f}{\partial p_i}\frac{\partial p_i}{\partial \tau_i}$, $\frac{\partial \zeta_f}{\partial p_i} = -\frac{(1-\varepsilon_Q)}{p_i}\zeta_f \zeta_i$

and $\frac{\partial p_f}{\partial \tau_i} = \gamma_v \frac{p_f}{\tau_i} \eta^H_{fv} \chi_{fvi} \varphi_i$. Combining all elements together,

$$\frac{dx_f}{d\tau_i} = x_f \left[-\left(1-\varepsilon_Q\right)\zeta_i - \gamma_v \eta^H_{fv} \chi_{fvi} \right] \frac{\varphi_i}{\tau_i}$$

Then

$$\begin{aligned}
\frac{d \ln U}{d \ln \tau_i} &= \sum_l \frac{\partial g}{\partial x_l} \tau_i \frac{dx_l}{d\tau_i} \\
&= \left[\frac{\zeta_i}{x_i} \tau_i \frac{dx_i}{d\tau_i} + \sum_{f \neq i} \frac{\zeta_f}{x_f} \tau_i \frac{dx_f}{d\tau_i} \right] \\
&= \left[-\zeta_i - \sum_{f \neq i} \zeta_f \gamma_v \eta^H_{fv} \chi_{fvi} \right] \varphi_i \\
&= -\lambda_i \varphi_i
\end{aligned}$$

where the next to last follows because $(1-\zeta_i) = \sum_{f \neq i} \zeta_f$.

B Tables and Graphs

Table A1: **Example variation in *Exposure***

Within product			
HS product	Mean	Min (e.g.)	Max (e.g.)
Low-*Exposure* (below mean)			
852329 Magnetic media; other than cards incorporating a magnetic stripe...	0.03	0 (Sweden)	0.53 (Ireland)
843999 Machinery; parts of machinery for making or finishing paper...	0.06	0 (Canada)	0.83 (Belgium)
760820 Aluminium; tubes and pipes, alloys	0.10	0 (Japan)	0.90 (Romania)
560311 Nonwovens; whether or not impregnated, coated...	0.10	0 (South Korea)	0.95 (UK)
720851 Iron or non-alloy steel; (not in coils), flat-rolled...	0.11	0 (Finland)	1 (Poland)
High-*Exposure* (above mean)			
310520 Fertilizers, mineral or chemical; containing the three fertilizing elements...	0.82	0 (UAE)	1 (Romania)
271119 Petroleum gases and other gaseous hydrocarbons...	0.74	0 (Switzerland)	1 (Norway)
310510 Fertilizers, mineral or chemical; in tablets or similar forms...	0.70	0 (Denmark)	1 (Greece)
271019 Petroleum oils and oils from bituminous minerals...	0.59	0 (Hungary)	1 (Czech Rep.)
521031 Fabrics, woven; containing less than 85% by weight of cotton...	0.55	0 (USA)	1 (Japan)

Within source country			
Country	Mean	Min	Max
Low-*Exposure* (below mean)			
Venezuela	0.05	0	1
Bangladesh	0.07	0	1
Macao, SAR China	0.09	0	1
China	0.12	0	1
Estonia	0.15	0	1
High-*Exposure* (above mean)			
Cyprus	0.52	0	1
Greece	0.34	0	1
Kyrgyzstan	0.32	0	1
Peru	0.29	0	1
Bulgaria	0.28	0	1

Table A2: **Variation in the Share of Imports with External Financing**

	All		$Exposure_{v,t=2010} > 0$	
	R^2	Adjusted R^2	R^2	Adjusted R^2
Fixed effects				
t	0.003	0.003	0.025	0.025
v	0.415	0.279	0.414	0.315
t,v	0.417	0.282	0.427	0.331
ct,v	0.421	0.284	0.435	0.337
pt,v	0.464	0.294	0.504	0.350
ct,pt,v	0.467	0.296	0.513	0.358
Number of vt pairs	589,404	589,404	256,753	256,753

Notes: This table shows variation of $Exposure_{vt}$ over the 2004-2011 period that is explained by various fixed ef (v), country-time (ct), and product-time (pt).

Table A3: **Summary Statistics for Direct and Indirect Exposure Measures**

	Variable		
	$Exposure$	$Exposure^{Suppliers}$	$Exposure^{Buyers}$
	Importers		
Mean	0.018	0.008	0.025
Median	0.004	0.005	0.002
$75th$ pctile	0.021	0.010	0.007
$95th$ pctile	0.081	0.028	0.022
Std dev	0.035	0.011	0.013
Number of firms	15,793	15,793	15,793
	All firms		
Mean	0.005	0.007	0.005
Median	0	0.003	0.001
$75th$ pctile	0	0.009	0.004
$95th$ pctile	0.031	0.029	0.020
Std dev	0.020	0.013	0.021
Number of firms.	54,968	54,968	54,968

Table A4: **Direct Effect of the Shock on Firms' Switches of Payment Terms**

Dep. vrb.:$\Delta_{11-12} Exposure_f^{Actual}$	OLS	OLS (RF)	IV
	(1)	(2)	(3)
$\Delta \ln \tau_f^{Actual}$	-12.57**		-18.11**
	(2.812)		(8.911)
$\Delta \ln \tau_f$		-20.48**	
		(9.858)	
R^2	0.237	0.243	
N	5,668	5,668	5,668
Fixed effects	i-r	i-r	i-r
KP test stat			491.7

Notes: Dependent variable is the change in the share of RUSF-affected imports of firm f operating in industry i and located in region r between 2011-2012. The fixed effects are at the industry-region level. Sample includes importers only. *, **, *** represent significance at the 10, 5, and 1 percent levels, respectively. Robust standard errors (in parentheses) are clustered at the industry-region level.

Table A5: **Direct Effect of the Shock: Robustness tests**

Dep var:	$\Delta_{11-12}\left(\frac{\text{Imports}}{\text{Total input purchases}}\right)_f$	$\Delta_{11-12}\left(\frac{\text{Total input purchases}}{\text{Total costs}}\right)_f$	$\left(\frac{\text{New suppliers in 2012}}{\text{Suppliers in 2010}}\right)_f$	$\Delta_{11-12}\ln Sales_f$
Panel A: Placebo test based on processing imports				
$\Delta \ln \tau_f^{Processing}$	-0.349	0.211	3.350	2.230
	(1.152)	(0.749)	(14.01)	(12.00)
R^2	0.021	0.032	0.033	0.030
N	45,583	45,583	45,583	45,583
Panel B: Controlling for source-country GDP per capita growth				
$\Delta \ln \tau_f$	-1.217***	1.109***	14.31***	-7.320***
	(0.262)	(0.401)	(4.883)	(2.545)
Weighted GDPpc growth$_f$	-0.019	0.069**	1.850***	0.447**
	(0.018)	(0.029)	(0.394)	(0.187)
R^2	0.032	0.032	0.032	0.027
N	54,968	54,968	54,968	54,968
Panel C: Controlling for currency composition of imports				
$\Delta \ln \tau_f$	-1.163***	0.966**	14.05***	-6.755***
	(0.261)	(0.418)	(5.087)	(2.592)
Weighted USD-denomination$_f$	-0.004	0.013***	0.211***	0.022
	(0.003)	(0.004)	(0.053)	(0.029)
R^2	0.032	0.032	0.032	0.026
N	54,968	54,968	54,968	54,968
Panel D: Controlling for leverage ratio				
$\Delta \ln \tau_f$	-1.354***	1.324***	19.93***	-6.232**
	(0.260)	(0.367)	(5.004)	(2.558)
Leverage ratio$_{f,t=2010}$	0.000	0.0004*	0.003***	-0.0003
	0.000	(0.0002)	(0.001)	(0.001)
R^2	0.033	0.032	0.032	0.026
N	54,968	54,968	54,968	54,968
Fixed effects	i-r	i-r	i-r	i-r
Firm-level controls	Yes	Yes	Yes	Yes

Notes: This table shows the results from estimating specification in equation (11) where the dependent variable changes across columns as follows. It is the annual change in the share of imports in total input purchases in column (1), annual change in the share of input purchases in total costs (where total costs are defined as input purchases and wages) in column (2), new domestic supplier links established in 2012 in column (3), and the growth rate of sales of firm f operating in industry i and located in region r in column (4). τ_f captures the firm-level effective tax rate, as defined in equation (2). $\tau_f^{Processing}$ is a modified version of τ_f in which the exposure is based on firm's processing goods imports that are not subjected to the RUSF tax. All columns in both panels include Employment$_{f,t=2010}$ and Import Intensity$_{f,2010}$ as additional controls. $\ln$ Employment$_{f,t=2010}$ is the logarithm of the number of employees, and Import Intensity$_{f,2010}$ the share of imports in total costs of firm f in 2010. In panel B, Weighted GDPpc growth is defined as $\sum_c \omega_{fc,t=2010} \times$ GDPpc growth$_c^{2010-2012}$, where $\omega_{fc,t=2010}$ is the share of source country c in firm's total costs as of 2010. In panel C, Weighted USD-denomination is defined as a weighted average of the share of imports denominated in USD at the variety level as of 2010, and the weights are $\omega_{fv,t=2010}$ as defined in equation (1). In the bottom panel, leverage ratio is defined as the ratio of total debt to assets, calculated for the year 2010. The fixed effects are at the industry-region (ir) level. *, **, *** represent significance at the 10, 5, and 1 percent levels, respectively. Robust standard errors (in parentheses) are clustered at the industry-region level.

Table A6: **Direct Effect of the Shock on Firm-level Sales: Comparing estimates from different datasets.**

	TSI dataset			Main (MoIT) dataset
	OLS		IV	OLS
Dep var:$\Delta_{11-12} \ln Sales_f$	(1)	(2)	(3)	(4)
$\Delta \ln \tau_f^{Actual}$	-5.222***		-8.605***	
	(1.723)		(2.834)	
$\Delta \ln \tau_f$		-9.687***		-9.730***
		(3.307)		(2.122)
R^2	0.061	0.061	0.0245	
0.024				
N	28,825	28,825	28,825	58,409
Fixed effects	i-r	i-r	i-r	i-r
Firm-level controls	Yes	Yes	Yes	Yes
KP test stat			594.3	

Notes: This table shows the results from estimating specification in equation (11) (without additional controls) where the dependent variable is the growth rate of sales of firm f operating in industry i and located in region r between 2011 and 2012. $\Delta \ln \tau_f$ and $\Delta \ln \tau_f^{Actual}$ are defined in equations (2) and (4)). Fixed effects are at the industry-region (i-r) level.*, **, *** represent significance at the 10, 5, and 1 percent levels, respectively. Robust standard errors (in parentheses) are clustered at the industry-region (i-r) level.

Table A7: **Direct and Indirect Effects of the Shock: Sum of first- and second-degree exposures**

Dep var:	$\Delta_{11-12}\left(\frac{\text{Imports}}{\text{Total input purchases}}\right)_f$	$\Delta_{11-12}\left(\frac{\text{Total input purchases}}{\text{Total costs}}\right)_f$	$\left(\frac{\text{New suppliers in 2012}}{\text{Suppliers in 2010}}\right)_f$	$\Delta_{11-12} \ln Sales_f$
	(1)	(2)	(3)	(4)
$\Delta \ln \tau_f$	-1.277 ***	1.377***	19.50***	-5.345**
	(0.262)	(0.370)	(5.195)	(2.656)
$\Delta \ln \tau_f^{Suppliers}$	-0.076	0.992**	-7.804	-5.396**
	(0.068)	(0.404)	(6.848)	(2.375)
$\Delta \ln \tau_f^{Buyers}$	0.003	-0.006	0.563	-0.002
	(0.003)	(0.005)	(1.670)	(0.009)
R^2	0.0317	0.0318	0.0316	0.0266
N	54,968	54,968	54,968	54,968
Fixed effects	i-r	i-r	i-r	i-r
Firm-level controls	Yes	Yes	Yes	Yes

Notes: This table shows the results from estimating specification in equation (12) where the dependent variable changes across columns as follows. It is the annual change in the share of imports in total input purchases in column (1), annual change in the share of input purchases in total costs (where total costs are defined as input purchases and wages) in column (2), new domestic supplier links established in 2012 in column (3), and the growth rate of sales of firm f operating in industry i and located in region r in column (4). τ_f captures the firm-level effective tax rate, as defined in equation (2). $\tau_f^{Suppliers}$ and τ_f^{Buyers} are defined similarly in equations (7) and (8). We construct them by adding $Exposure^{SoS}_{f,t=2010}$ to $Exposure^{Suppliers}_{f,t=2010}$, and $Exposure^{BoB}_{f,t=2010}$ to $Exposure^{Buyers}_{f,t=2010}$. All columns include $\ln \text{Employment}_{f,t=2010}$, i.e. the logarithm of the number of employees, and Import $\text{Intensity}_{f,t=2010}$, i.e. the share of imports in total costs of firm f in 2010, as additional controls. The fixed effects are at the industry-region (ir) level. *, **, *** represent significance at the 10, 5, and 1 percent levels, respectively. Robust standard errors (in parentheses) are clustered at the industry-region level.

Table A8: **Role of Financial Constraints: Alternative measure of liquidity**

Dep var:	$\Delta_{11-12}\left(\frac{\text{Imports}}{\text{Total input purchases}}\right)_f$	$\Delta_{11-12}\left(\frac{\text{Total input purchases}}{\text{Total costs}}\right)_f$	$\left(\frac{\text{New suppliers in 2012}}{\text{Suppliers in 2010}}\right)_f$	$\Delta_{11-12}\ln Sales_f$
	(1)	(2)	(3)	(4)
$\Delta\ln\tau_f$	-1.281***	1.482***	20.84*	-9.044***
	(0.373)	(0.351)	(5.420)	(3.190)
$Unconstrained_{f,2010} * \Delta\ln\tau_f$	0.152	-0.240**	3.791	5.631*
	(0.470)	(0.122)	(6.558)	(3.177)
$\Delta\ln\tau_f^{Suppliers}$	-0.125	1.498**	-15.03	-8.981*
	(0.125)	(0.595)	(11.24)	(4.721)
$\Delta\ln\tau_f^{Buyers}$	-0.006	-0.001	-0.532	-0.004
	(0.010)	(0.005)	(0.503)	(0.003)
R^2	0.0338	0.0324	0.0353	0.0284
N	54,968	54,968	54,968	54,968
Fixed effects	i-r	i-r	i-r	i-r
Firm-level controls	Yes	Yes	Yes	Yes

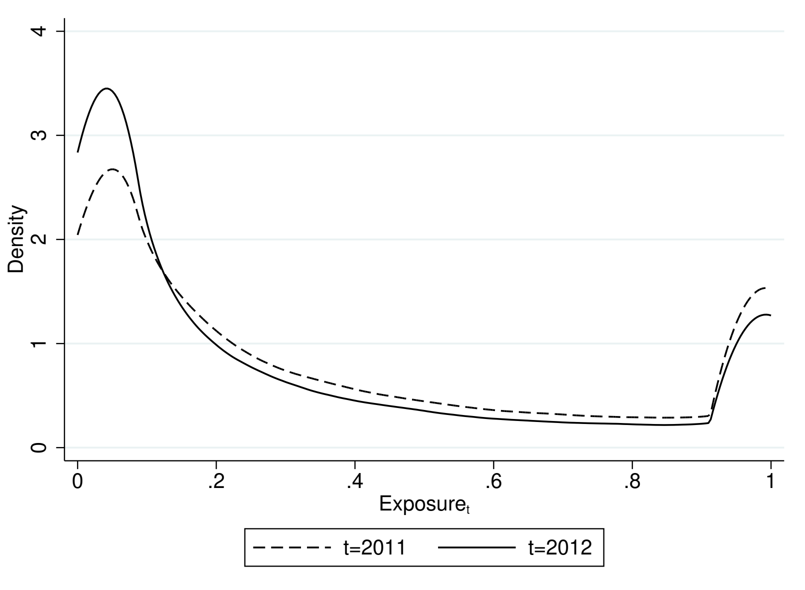
Notes: This table shows the results from estimating an extended version of the specification in equation (12) where the dependent variable changes across columns as follows. It is the annual change in the share of imports in total input purchases in column (1), annual change in the share of input purchases in total costs (where total costs are defined as input purchases and wages) in column (2), new domestic supplier links established in 2012 in column (3), and the growth rate of sales of firm f operating in industry i and located in region r in column (4). τ_f captures the firm-level effective tax rate, as defined in equation (2). $\tau_f^{Suppliers}$ and τ_f^{Buyers} are defined similarly in equations (7) and (8). $Unconstrained_{f,t=2010}$ is a dummy variable indicating liquidity-unconstrained firms, which have a quick ratio, i.e. ratio of the sum of cash, marketable securities and accounts receivables to current liabilities, above their 2-digit NACE industry average in 2010. All columns include $\ln \text{Employment}_{f,t=2010}$, i.e. the logarithm of the number of employees, and Import $\text{Intensity}_{f,2010}$, i.e. the share of imports in total costs of firm f in 2010, and $Unconstrained_{f,t=2010}$ as additional controls. The fixed effects are at the industry-region (ir) level. *, **, *** represent significance at the 10, 5, and 1 percent levels, respectively. Robust standard errors (in parentheses) are clustered at the industry-region level.

Table A9: **Role of Financial Constraints: Interaction with initial firm size**

Dep var:	$\Delta_{11-12}\left(\frac{\text{Imports}}{\text{Total input purchases}}\right)_f$	$\Delta_{11-12}\left(\frac{\text{Total input purchases}}{\text{Total costs}}\right)_f$	$\left(\frac{\text{New suppliers in 2012}}{\text{Suppliers in 2010}}\right)_f$	$\Delta_{11-12}\ln Sales_f$
	(1)	(2)	(3)	(4)
$\Delta\ln\tau_f$	-1.576***	1.215***	7.888*	-12.540***
	(0.307)	(0.426)	(4.663)	(3.106)
$Unconstrained_{f,2010} * \Delta\ln\tau_f$	-0.280	-1.309*	8.323*	13.680***
	(0.426)	(0.732)	(5.017)	(4.696)
$\Delta\ln\tau_f^{Suppliers}$	-0.112	1.502**	-14.260	-7.104**
	(0.112)	(0.602)	(9.439)	(3.567)
$\Delta\ln\tau_f^{Buyers}$	0.005	-0.001	0.872	-0.004
	(0.004)	(0.005)	(0.373)	(0.003)
$\ln Employment_{f,2010} * \Delta\ln\tau_f$	-0.677***	-0.891***	-13.91***	-4.313***
	(0.183)	(0.258)	(2.593)	(1.538)
R^2	0.0330	0.0321	0.0303	0.0268
N	54,968	54,968	54,968	54,968
Fixed effects	i-r	i-r	i-r	i-r
Firm-level controls	Yes	Yes	Yes	Yes

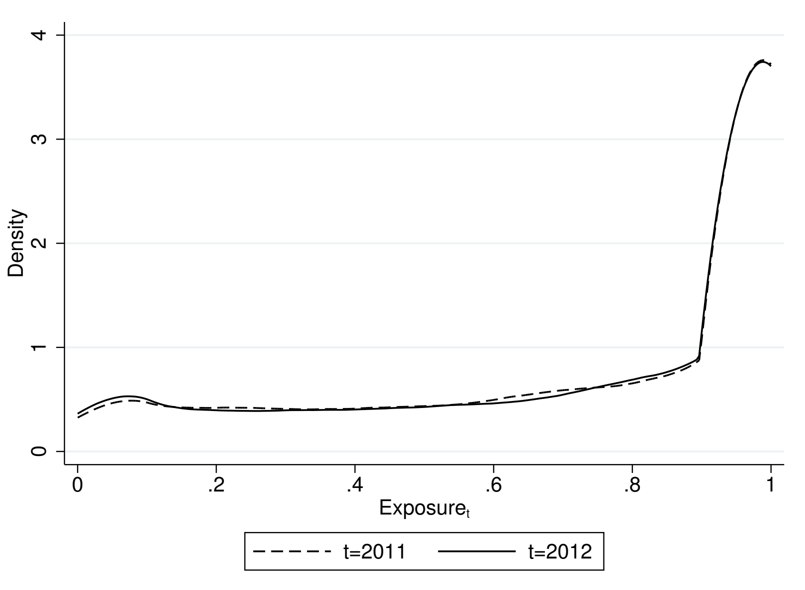
Notes: This table shows the results from estimating an extended version of the specification in equation (12) where the dependent variable changes across columns as follows. It is the annual change in the share of imports in total input purchases in column (1), annual change in the share of input purchases in total costs (where total costs are defined as input purchases and wages) in column (2), new domestic supplier links established in 2012 in column (3), and the growth rate of sales of firm f operating in industry i and located in region r in column (4). τ_f captures the firm-level effective tax rate, as defined in equation (2). $\tau_f^{Suppliers}$ and τ_f^{Buyers} are defined similarly in equations (7) and (8). $Unconstrained_{f,t=2010}$ is a dummy variable indicating liquidity-unconstrained firms, which have an implied interest rate on their existing debt below their 2-digit NACE industry average in 2010. All columns include $\ln \text{Employment}_{f,t=2010}$, i.e. the logarithm of the number of employees, and Import $\text{Intensity}_{f,2010}$, i.e. the share of imports in total costs of firm f in 2010, and $Unconstrained_{f,t=2010}$ as additional controls. The fixed effects are at the industry-region (ir) level. *, **, *** represent significance at the 10, 5, and 1 percent levels, respectively. Robust standard errors (in parentheses) are clustered at the industry-region level.

Figure A1: Distribution of Share of Imports with External Financing at the Product-Country Level



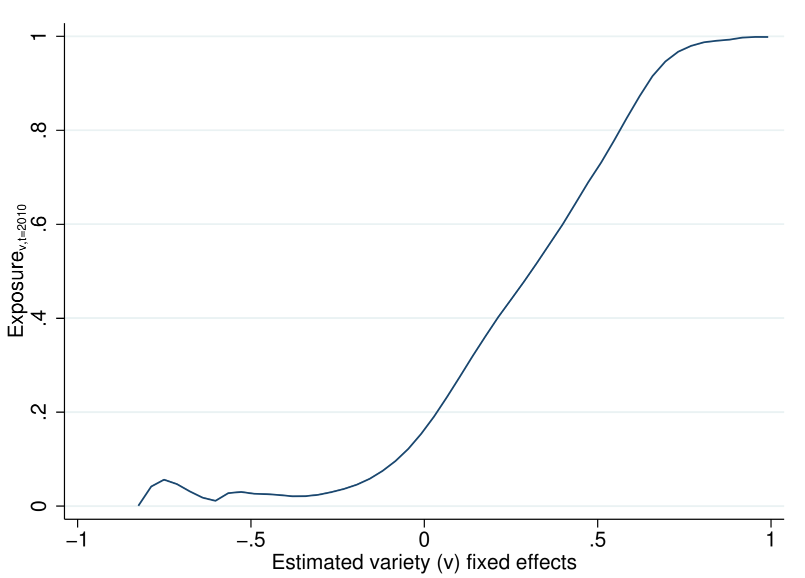
Notes: This figure illustrates the distribution of the share of ordinary imports with external financing in 2011 and 2012. Recall that the policy shock took place in the mid-October of 2011 and thus t = 2011 can be considered to be the pre-shock period.

Figure A2: Distribution of Share of Imports with External Financing at the Product-Country Level: Processing imports



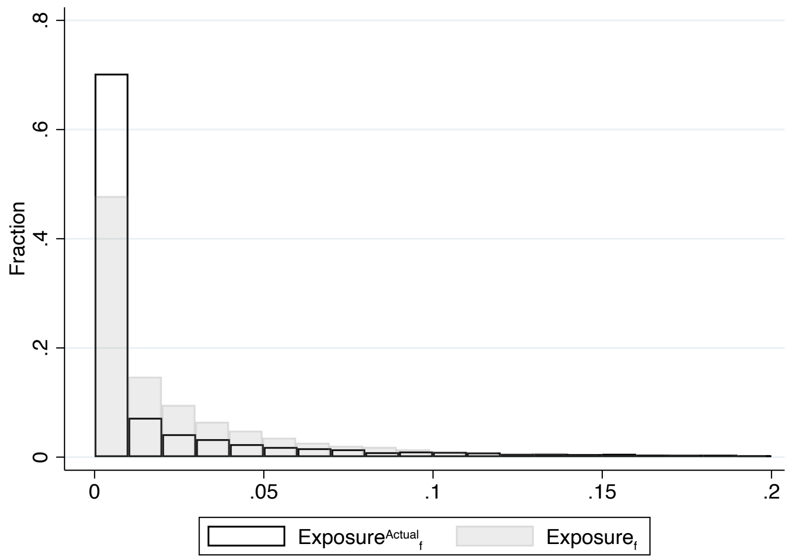
Notes: This figure illustrates the distribution of the share of processing imports with external financing in 2011 and 2012. Recall that the policy shock took place in the mid-October of 2011 and thus t = 2011 can be considered to be the pre-shock period.

Figure A3: Stability of Reliance on External Financing at the Product-Country Level



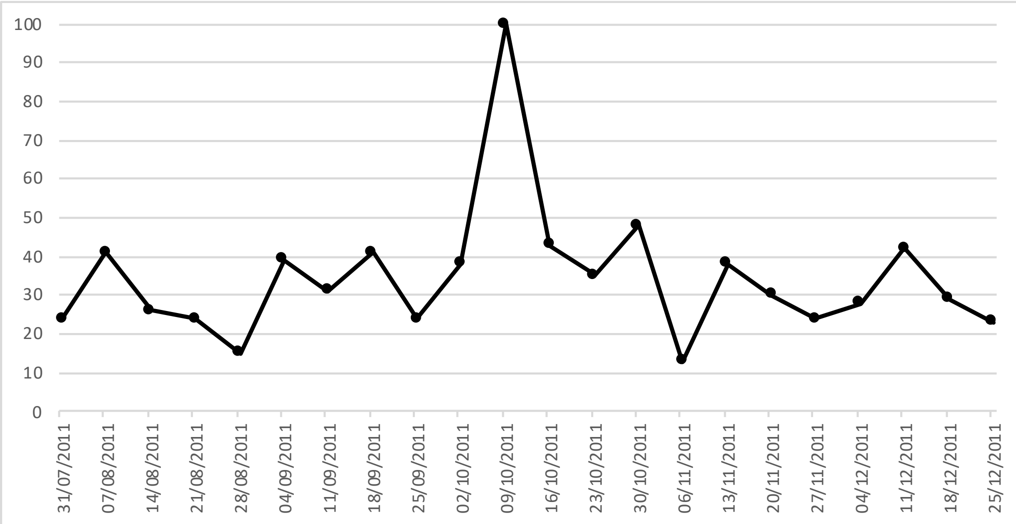
Notes: This figure plots the share of imports with external financing at the product-country (variety) level ($Exposure_v$) in 2010 against the variety-level average over the 2004-2011 period. The latter is obtained by regressing $Exposure_{vt}$ on year and variety-level fixed effects.

Figure A4: Distribution of Actual and Bartik-type Exposure to RUSF



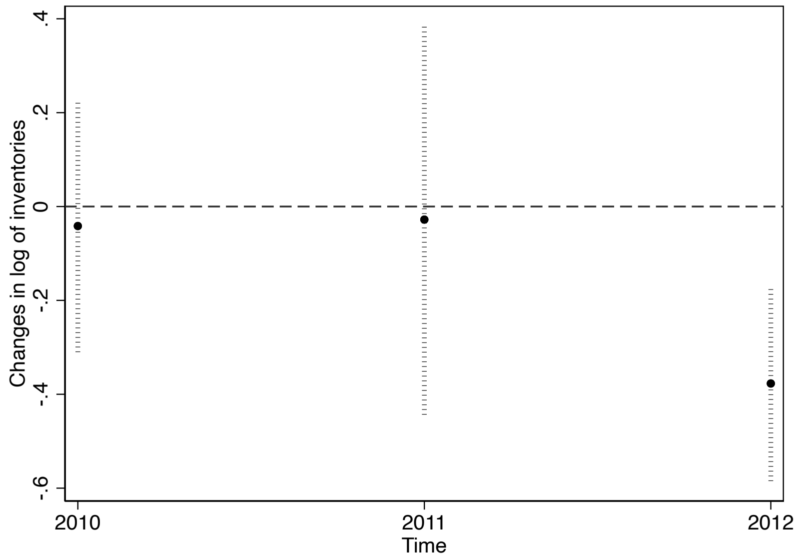
Notes: This figure plots distribution of actual and Bartik-type exposure to the RUSF shock at the firm level as defined in equations (3) and (1), respectively.

Figure A5: Searches for RUSF on Google



Notes: This figure shows the intensity of weekly searches involving "KKDF" or "Kaynak Kullanımını Destekleme Fonu" on Google before and after the increase in the RUSF rate on October 13, 2011. The vertical line marks the week of the policy change.

Figure A6: Firm Inventories and Exposure to Shock



Notes: This figure shows the estimated coefficient (and the associated 95% confidence intervals) on the share of firm-level imports with external financing calculated as of 2010 for different time periods in the following regression equation: $\Delta \ln \text{Inventories}_{f,t=l} = \beta_l \left(\frac{\text{Imports with external financing}}{\text{Total imports}} \right)_f + \alpha_{ir} + \epsilon_f$, where $l = 2010, 2011, 2012$; i indexes industries, and r regions.

Figure A7: Illustration of Network Structure

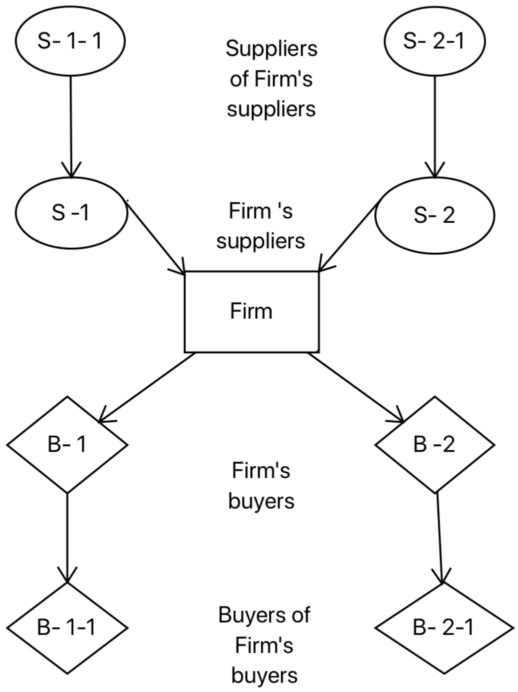
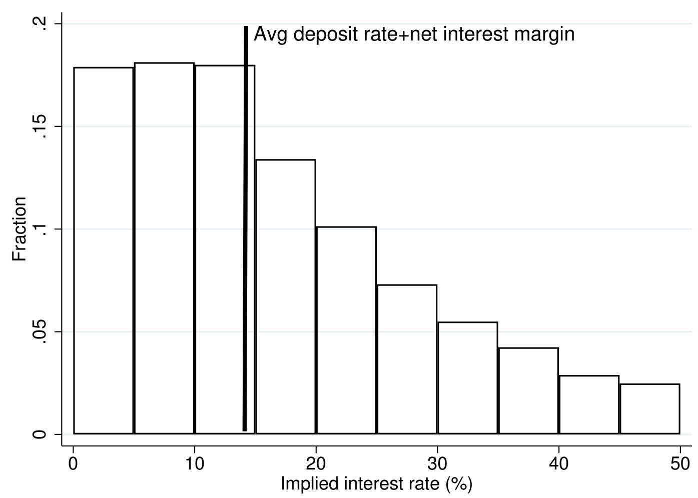


Figure A8: Distribution of Implied Interest Rate



Notes: Average deposit rate is the weighted average of the interest rate paid by deposit banks for deposits with longer than 1-year maturity. Net interest margin is a measure of efficiency. It is calculated as net interest income as a percentage of interest-earning assets.