Financial Constraints and Propagation of Shocks in Production Networks *

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This study finds that small unexpected supply shocks propagate through production networks, amplified by firms with short-term financial constraints. Our data cover almost all Turkish supplier-customer links. The unexpected 2011 increase in the tax on imports purchased with foreign credit, which affected importers heterogeneously, provides the identification. This shock had a non-trivial economic impact on exposed firms and propagated downstream through affected suppliers. A simple theory and empirical tests demonstrate that low-liquidity firms amplified its transmission.

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1 Introduction

Since the seminal work of Acemoglu, Carvalho, Ozdaglar, and Tahbaz-Salehi (2012), research has focused on investigating the channels through which economic shocks are transmitted within economies. The resulting papers typically make use of large economic shocks affecting firms (e.g., the natural disasters in Barrot and Sauvagnat (2016) and Boehm, Flaaen, and Pandalai-Nayar (forthcoming)), or rely on economy-wide shocks and identify network connections through input-output tables (e.g., Acemoglu, Akcigit, and Kerr (2016)). Our article contributes to this line of work, yet differs from the existing papers in a number of dimensions. First, we study the propagation of a much smaller unexpected shock, which heterogeneously affects a portion of firms in the production chain, and find that it not only has a direct effect but it also gets transmitted downstream though the production network. Second, in trying to understand the underlying mechanisms of shock transmission, we study the role of financial constraints. Our focus is on the liquidity constraints, as the small unexpected regulatory shock that we examine is likely to affect firms in the short-run, but unlikely to have a material effect in the longer-run. Third, we conduct our analysis using data that cover the quasi-totality of an open economy's production network. As a result, we are able to draw inferences that might be harder to observe with firm or industry-segment data used in the existing studies.

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 only applies to import transactions backed by international trade financing that counts as a credit from non-domestic sources. This regulatory shock had a heterogenous impact across Turkish firms that import because of the use of international trade credit subjected to the increased tax differed across importers. Since the increase in the RUSF import duty was unexpected, an immediate 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 financial liquidity positions played a role in the transmission or

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

absorption of the said 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/or 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 relatively small 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.

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 temporary slowdown in sales growth relative to firms with lesser or no exposure to the same shock. This observed effect is a short-term one. It is visible in the year following the import tax increase, and it attenuates in the years after. However, at the same time, the exposed firms also experience a decline in import intensity, an increase in their reliance on domestic purchases and the number of new domestic suppliers. Their supplier networks are modified, suggesting that the tax increase induces an input reallocation towards domestic inputs.[2] The adjustment of the sourcing pattern begins in the year after the shock and continues in the subsequent two years. This result 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 suppliers. Second, in line with Acemoglu, Akcigit, and Kerr (2016) results, we find that the supply-shock that we consider propagates downstream through

[2] 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.

the exposed suppliers, but not upstream through the affected buyers. Third, we find that the transmission of the shock through domestic suppliers is as large as the effect of the own exposure to the shock. When we investigate further, we find that liquidity-constrained importers are hit harder by the shock, both directly and via their suppliers. Moreover, 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.

Although our paper focuses on a particular policy episode, 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 a search cost in the process.[3]

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 natural disasters in the US, that affect publicly-listed suppliers, have economically important effects on their publicly-listed client firms. Carvalho, Nirei, Saito, and Tahbaz-Salehi (2016) and Boehm, Flaaen, and Pandalai-Nayar (forthcoming) focus on the 2011 Tohoku Earthquake and provide more evidence on the propagation of shocks through 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 input-output tables from the US in their empirical analysis. 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, while the supply shocks, such as TFP and patenting shocks, 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 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

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

data, 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 (2019); Bigio and La'O (2016); Jacobson and von Schedvin (2015); Boissay and Gropp (2013); and Kalemli-Ozcan, Kim, Shin, Sorensen, and Yesiltas (2014)).[4] 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 small economic shocks can have economically non-negligible effects. Equally importantly, our results 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 cost-shock, by local alternatives from domestic suppliers.

Finally, our work is related to the recently 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. We contribute to this literature by examining the changes in the network of domestic suppliers as well as foreign versus domestic intermediates substitution in the face of a small yet 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 the empirical approach. Section 4 presents the main results on the direct and indirect impacts of the shock. The first part of Section 5 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

[4] Bigio and La'O (2016) 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. As expected, 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, arises due to general equilibrium effects. Jacobson and von Schedvin (2015) study exposure of Swedish firms to 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 shock and default through trade credit. In contrast, companies that are financially unconstrained help stop the payment default chain.

second part of the same section takes these predictions to the data. Section 6 concludes the paper.

2 Institutional Context

The imports-related RUSF contribution was instituted by the 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 such changes therein require no prior parliamentary debate. Before 2011, this particular tax imposed a 3% levy on 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%.[5]

The RUSF tax is implemented by the Turkish Customs and Trade Ministry that 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.

More specifically, the RUSF levy applies to imports that are foreign-financed by open account (OA), acceptance credit (AC), and deferred-payment letter of credit (DLC). 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

[5]Google Trends statistics, presented in Figure 1, do not show a trend for the number of searches involving "Kaynak Kullanımını Destekleme Fonu" (which is the Turkish name of the tax) or "KKDF" (its acronym) before the week of 9 October 2011. During the latter week the number of searches peaks. Also, Figure 2 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 suggest that the tax increase was unanticipated.

involves bank intermediation without a payment guarantee). Finally, the RUSF levy applies only to ordinary imports financed through international trade credit. 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 Empirical Strategy

3.1 Data

To conduct our analysis, we combine data from three Turkish administrative datasets accessed on the premisses of the Turkish Statistical Institute (TSI) as well as the Turkish Ministry of Science, Industry and Technology (MSIT).[7] The first dataset, available at the TSI, is based on detailed customs data. It allows us to trace all Turkish imports disaggregated by the importing firm, source country, 6-digit Harmonized System (HS6) product code, trade regime (i.e., ordinary or processing), and trade financing type (i.e., cash in advance, letter of credit, open account, etc.).

Due to confidentiality reasons, we cannot transfer firm-level import financing data, which allow us to trace imports subjected to RUSF, from the TSI and match them with the other two MSIT datasets that we describe below. 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 two other MSIT datasets with a view to create a Bartik-type instrument. This measure is constructed based on ordinary imports and defined as follows:

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

where v indexes input variety (i.e., country-product pairs), m trade financing types (including OA, AC, and DLC covered 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 categories,

[6] The fact that processing imports are not subjected to RUSF allows us to use them in a placebo test as of the same date as this levy's increase in October 2011.

[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 MSIT and TSI staff.

and corresponds to approximately 75,000 country-product pairs. Figure 3 presents the frequency distribution of $Exposure_{v,t}$ for $t = 0$ (i.e., 2011, the year of the shock) and $t = 1$ (i.e., 2012).[8] 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]

The second dataset used in our study is maintained by the MSIT for the purpose of calculating and collecting the value added tax (VAT). This dataset covers all domestic firm-to-firm transactions 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. 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. Given the low annual threshold of firm-pair payments, we observe almost all domestic supplier-buyer pairs in Turkey. These data provide us with the nearly complete picture of the country's production network. As our identification is driven by the increase in a border tax that applies to imported goods, we exclude service sector firms. Moreover, we drop micro entities that do not report balance sheets or income statements.[10] We also exclude food and beverage manufacturers, as they were affected by a change in the VAT rate around the same time as the RUSF shock that we use for identification. We further drop firms with missing values for the outcome variables of interest. These restrictions leave us with slightly more than 69,000 manufacturing firms in the final sample. To these MSIT data, we add the TSI data-based HS6 product code-country-year specific *Exposure* variable at the firm-HS6 product code-year level.[11]

Finally, we combine the firm-to-firm transaction data with firm-level financial statement data, also maintained by the MSIT. The annual balance sheet and income statements allow us to calculate

[8] As illustrated in Online Appendix Table A7, there is a lot of variation in *Exposure* across products within source countries as well as across source countries within the imported product.

[9] A similar graph (available upon request) based on the processing imports for the same years shows no such shift.

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

[11] Even though the MSIT's customs dataset contains firms' imports figures at the HS6 product code-country-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, we import the payment-type based HS6 product code-country *Exposure* from TSI dataset into the MSIT dataset and match it at the HS6 product code-import country level for each firm (see Section 3.2 for more detail).

outcome variables (such as sales growth), as well as control variables (such as leverage or liquidity ratios).

3.2 Empirical strategy

Firm-level exposure, which is the key variable in our analysis, is constructed as a Bartik-type variable in the year prior to the tax increase (i.e., as of $t = -1$, which corresponds to year 2010) as follows:

$$Exposure_{f,t=-1} = \sum_{v} \omega_{f,v,t=-1} \times Exposure_{v,t=-1} \tag{1}$$

where $\omega_{f,v,t=-1}$ 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 $t = -1$ (i.e., as of year 2010).[12] ,

One limitation of the customs dataset available at MSIT is that it does not report information on payment methods. Therefore, 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 was 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 make sure that our Bartik-type exposure variable in equation (1) tracks the actual exposure, we use the TSI customs database where the actual exposure can be fully measured using information on payment methods.[13] We use firm-level data from year $t = -1$ and regress the actual exposure on the Bartik-type exposure variable using a local polynomial regression with industry-region fixed effects. We plot the resulting coefficient estimates in Figure 4. It is reassuring that the two exposure variables are highly correlated. The OLS estimate of the regression slope is 0.90 with a standard error of 0.02, and the value of F-statistic is well above the critical value. More importantly, the estimate is not statistically different from one. This implies that 2SLS estimation,

[12] Defining $\omega_{f,v,t=-1}$ as a fraction of total domestic purchases and imports (i.e., after excluding labor costs) did not change our main results.

[13] Note that both TSI and MSIT datasets administrative datasets that cover the universe of Turkish firms. Therefore, we are not concerned about the differences in the represenativeness of the two datasets.

where the Bartik-type exposure variable is used as an instrument for the actual firm-level exposure, would generate an estimate that is is very close to the reduced-form estimate.[14]

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

$$Exposure^{Suppliers}_{f,t=-1} = \sum_{s} \omega^{S}_{f,s,t=-1} \times Exposure_{s,t=-1} \tag{2}$$

where $Exposure^{Suppliers}_{f,t=-1}$ is the firm f's exposure to the shock through its suppliers; and $\omega^{S}_{fs,t=-1}$ is the share of supplier s in firm f's total variable costs 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:

$$Exposure^{Buyers}_{f,t=-1} = \sum_{b} \omega^{B}_{f,b,t=-1} \times Exposure_{b,t=-1} \tag{3}$$

where $\omega^{B}_{f,b,t=-1}$ is the share of buyer b in firm f's total sales in year 2010.

We also 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:[15]

$$\begin{aligned} Exposure^{SoS}_{f,t=-1} &= \sum_{s} \omega^{S}_{f,s,t=-1} \times Exposure^{Suppliers}_{s,t=-1} \\ Exposure^{BoB}_{f,t=-1} &= \sum_{b} \omega^{B}_{f,b,t=-1} \times Exposure^{Buyers}_{b,t=-1} \end{aligned} \tag{4}$$

The summary statistics for various exposure measures are presented in Tables 1 and 2. Table 1 decomposes firm's own exposure to the RUSF shock into two components: a Bartik-type exposure variable that captures 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). The decom-

[14]In an exactly identified model with one endogenous variable, we have $\beta^{2SLS} = \frac{\beta^{ReducedForm}}{\beta^{FirstStage}}$.
[15]See Figure 5 for an illustration.

position directly follows from equation (1):

$$\begin{aligned} Exposure_{f,t=-1} &= \sum_v \omega_{f,v,t=-1} \times Exposure_{v,t=-1} \\ &= \sum_v \frac{M_{f,v,t=-1}}{TotalCosts_{f,t=-1}} \times Exposure_{v,t=-1} \\ &= \sum_v \frac{M_{f,v,t=-1}}{TotalCosts_{f,t=-1}} \times \frac{M_{f,t=-1}}{M_{f,t=-1}} \times Exposure_{v,t=-1} \\ &= \underbrace{\frac{M_{f,t=-1}}{TotalCosts_{f,t=-1}}}_{\text{Import intensity}} \times \overbrace{\underbrace{\sum_v \frac{M_{v,f,t=-1}}{M_{f,t=-1}} \times Exposure_{v,t=-1}}_{\text{Share of firm's imports subject to RUSF}}}^{Exposure^M_{f,t=-1}} \end{aligned}$$

As expected, most firms do not import and hence have no direct exposure to the RUSF tax. The median direct exposure in the sample is zero. For importers, the average direct exposure amounts to 2.4% 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 2 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 0.1%. These figures are slightly higher for importers, reaching 0.6%.

As a first pass of the data, we investigate whether importers responded to the increase in the RUSF rate by changing the payment term composition of their imports after October 2011. Table 3 shows that importers that were using RUSF-affected payment terms more intensively before the date of the policy change substituted away from those payment terms after the RUSF rate was raised from 3% to 6%. Another implication of the results presented in this table is that the actual firm-level exposure and the Bartik-type exposure defined in equation (1) yield very similar estimates.

To investigate the effects of the RUSF tax increase, we construct the following variables that capture the effective tax increase ($\Delta \ln \tau_f$) at the firm-level through the direct (5a) and indirect (5b and (5c)) channels:

$$\Delta \ln \tau_f = \ln\left(\frac{1 + Exposure_{f,t=-1} \times \tau_{t=+1}}{1 + Exposure_{f,t=-1} \times \tau_{t=-1}}\right) \tag{5a}$$

$$\Delta \ln \tau_f^{Suppliers} = \ln\left(\frac{1 + Exposure_{f,t=-1}^{Suppliers} \times \tau_{t=+1}}{1 + Exposure_{f,t=-1}^{Suppliers} \times \tau_{t=-1}}\right) \tag{5b}$$

$$\Delta \ln \tau_f^{Buyers} = \ln\left(\frac{1 + Exposure_{f,t=-1}^{Buyers} \times \tau_{t=+1}}{1 + Exposure_{f,t=-1}^{Buyers} \times \tau_{t=-1}}\right) \tag{5c}$$

In the baseline specification, we focus on the direct impact of the tax increase, while in the later specifications we consider both the direct and the indirect impacts. The baseline specification takes the form of a difference-in-differences model with a differenced dependent variable over either one, two, or three years (that is, between 2012-2011, 2013-2011, or 2014-2011, respectively), which allows us to trace the cumulative impact of the RUSF shock over time:

$$\Delta_t \ln Y_f = \beta_t \Delta \ln \tau_f + \alpha_{i,r} + \epsilon_f \tag{6}$$

where Y_f is an outcome variable (e.g., sales) for firm f operating in industry i and region r; $\Delta_t \ln Y_f = \ln Y_{f,t} - \ln Y_{f,t=0}$ is the change in the logarithm of Y between $t = \{1, 2, 3\}$ (i.e., 2012, 2013, 2014, respectively) and $t = 0$ (i.e., 2011, which can be considered to be the year preceding the shock, as the tax increase took place only in the mid-October); i is one of the 22 two-digit NACE industry segments; and r corresponds to the 81 contiguous administrative regions into which Turkey is subdivided, with each region corresponding to a Turkish city (such as Ankara, Istanbul, Izmir, etc.).

In equation (6), β_t is the tax elasticity of outcome variable Y_f and it is composed of two parts: (i) elasticity of price with respect to tax ($\frac{\partial \ln p_f}{\partial \tau_f}$), and (ii) price elasticity of Y_f, which is $(1 - \varepsilon_H)$ under CES demand with elasticity ε_H.[16] We can recover the value of the tax elasticity of price by assuming a value for σ 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.

[16]See Appendix A.3.1 for a derivation of the two effects in equation (34). There is also a negligible effect due to substitution between foreign and domestic intermediates that we ignore here.

We add industry-and-region fixed effects ($\alpha_{i,r}$) to account for changes in the unobservables over one year for t=1, two years for t=2, etc., depending on how the differencing of the dependent variable is done. These fixed effects control for confounding factors or shocks that could vary at the economy-wide, industry, region, or industry-region levels over 1, 2, or 3 year periods. 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.[17]

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

$$\Delta_t \ln Y_f \quad = \quad \gamma_t \Delta \ln \tau_f + \gamma_{s,t} \Delta \ln \tau_f^{Suppliers} + \gamma_{b,t} \Delta \ln \tau_f^{Buyers} + \alpha_{i,r} + \upsilon_f \tag{7}$$

where, $\Delta_t \ln Y_f$, $\Delta \ln \tau_f$, $\Delta \ln \tau_f^{Suppliers}$, $\Delta \ln \tau_f^{Buyers}$, and $\alpha_{i,r}$ are defined as above. We use several variants of equation (7) in our analyses.

4 Results

4.1 Direct effect of the shock on sales growth

We begin by examining the direct effect of the unexpected RUSF duty increase from 3% to 6% on the affected firms' performance. For the time being, we ignore the network effects. Our first outcome of interest is the sales growth. Table 4 presents the estimates for the log change in sales between 2011 and 2012 (column 1), 2013 (column 2) and 2014 (column 3). As visible in the table, the tax shock had a negative and statistically significant impact on sales growth of the affected firms in 2012: The coefficient estimate β_t for $\Delta \ln \tau_f$ is equal to -11.73, and statistically significant at the 1%-level.[18] However, the effect seems to have been of temporary nature, as by 2013 the coefficient estimate on the change in the effective tax rate (though still negative, albeit smaller in absolute magnitude) ceases to be statistically significant. It remains insignificant when we examine

[17] Our results are robust to clustering standard errors at the 4-digit NACE-level industry-segments.

[18] In additional regressions (available upon request), we observe that total costs increase in a statistically significant manner in the year that follows the RUSF increase, but the effect disappears after the first period. This finding suggests that the drop in sales is related with the increase in costs in the short-term.

the sales growth over three years (last column).

The short-lived effect of the shock is illustrated in Figure 6 which graphs the estimates of β_t in equation (6) and the associated 95% confidence intervals for different time periods. The estimated coefficient has the largest magnitude in the year $t = 1$ (i.e., 2012) following the policy change taking place in the mid-October of 2011, i.e. $t = 0$. It is also the only time period in which it is significantly different from zero; the other coefficient estimates (i.e., the two periods prior and two periods after) are statistically insignificant.[19]

To interpret the magnitude of the effect in column 1, recall from Section 3.2 that β_t, the estimate for the tax elasticity for the outcome variable, here sales, is equal to the product of the two other elasticities $\frac{\partial \ln p_f}{\partial \tau_f} \times (1 - \varepsilon_H)$. To recover the value of the elasticity of price with respect to tax, we assume the price elasticity of sales to be $\varepsilon_H = 9.65$.[20] This gives a passthrough rate of tax to prices of 1.36,[21] which is comparable to the estimates of tariff passthrough onto producer prices reported in a recent paper by Amiti, Redding, and Weinstein (2019).[22] In our setting, the estimated passthrough rate of tax onto prices implies that for a firm at the 75th percentile of the distribution of $Exposure$, the implied price response is a 0.12 percentage points increase.[23]

To gauge the economic significance of the estimated effect, let us compare a firm at the $95th$ percentile of the distribution of $Exposure$ to a firm that is at its median. Our baseline estimate implies a 1.2 percentage points difference in growth rates of sales between these two firms. This difference is economically important as the average sales growth in the data is 9%.

To verify that the coefficient estimate that we observe in column 1 of Table 4 is really driven by

[19]The fact that the coefficient estimates $\beta_{t=-2}$ and $\beta_{t=-1}$ are not statistically significant suggests that the hypothesis of parallel trends for the treated and control groups in the pre-treatment period that is required for a difference-in-differences estimation holds true.

[20]This price elasticity of sales number is based on the findings of Head and Ries (2001) who focus on the US-Canada trade. As the latter two economies are very similar, we believe that their estimates are more appropriate in our within-Turkey context than others available in the literature. Head and Ries (2001) obtain price elasticities of sales 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.

[21]When we distinguish between high and low liquidity firms, this passthrough for high liquidity firms is 0.7 (see section 5.2).

[22]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 complete passthrough of the tariffs to import prices.

[23]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 further in section 4.2), they bear search costs and adjustment costs to the usage of new intermediate inputs. In the short run, these may increase the variable costs.

the changes in the RUSF tax, we conduct two placebo tests. In column 1 of Table A1, we assign a false RUSF increase date by moving the RUSF adoption date back by one year (i.e., we use October 2010 instead of the actual adoption date of October 2011). As expected, the coefficient of interest is not statistically significant at the conventional levels. In column 2 of the same table, we run another falsification test for which we construct $\tau_f^{Processing}$ based on $Exposure_{f,t=-1}^{Processing}$ using data on firms' processing imports and actual RUSF taxes of $\tau_{t=-1}$=0.03 and $\tau_{t=+1}$=0.06. Since the RUSF tax does not apply to processing imports, we should not see any response of sales growth to this placebo exposure measure. The results are consistent with this prior: The coefficient estimate of $\Delta \ln \tau_f^{Processing}$ in the second column is not statistically significant.

We conduct a number of additional checks to examine whether our coefficient estimate of tax elasticity of sales is driven by an omitted variable, such as size of the firm, relative importance of its imports or capital structure. In column 1 of Table A2, we control for firm size using the logarithm of the number of employees in 2010, as sales growth is likely to be slower for firms that are already large. Adding the control variable for size lowers the size of the coefficient estimate of interest to -9.01, which remains statistically significant at the 1%-level. Assuming $\sigma = 9.65$ as before, the corresponding elasticity of price to the RUSF tax is estimated to be 0.93. In column 2, to check whether other import-related shocks (e.g., exchange rate movements) could be affecting the baseline estimates, we add the ratio of total imports to sales as of 2010 (i.e., $(M/Sales)_{f,s,r,t=-1}$). The coefficient estimate of β_t remains similar in size to that of column 1 and statistically significant at the 1%-level. In the last two columns of Appendix Table A2, we examine whether our baseline results can be explained by the RUSF exposed-firms' capital structure, which are likely to be representative of their longer-term financial constraints. The specification in Column 3 includes $HighLev_{f,t=-1}$, a dummy variable indicating whether the firm's leverage was above its industry's median as of 2010. Column 4 specification includes the dummy variable $HighCredit_{f,t=-1}$ indicating whether the firm's total bank loans (most common type of corporate debt) to assets ratio was above the industry median as of 2010. Including these additional control variables does not affect the the estimates for β_t or their statistical significance. The last column includes all the additional controls at the same time: The estimate for β_t is equal to -9.89, suggesting an estimate of RUSF tax elasticity of price of 1.02 (assuming $\sigma = 9.65$).

4.2 Direct effect of the shock on the sourcing pattern

Next, we focus on the direct effect of the shock on the input sourcing pattern. 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. Moreover, in contrast to sales growth findings, the observed effects do not die out after one year, which is consistent with the fact that it takes time to switch from imported inputs and their foreign suppliers to domestic ones.

In the three columns of the top panel in Table 5, we consider the changes in the import intensity of sales (i.e., changes in the ratio of imports to sales) after the RUSF increase over one, two and three year periods, respectively. The coefficient estimate for the increase in the effective tax rate is negative and statistically significant at the 1%-level in all of the three columns: The increase in the RUSF tax has discouraged exposed-firms' use of imported inputs. The increase in the absolute magnitude of the $\Delta \ln \tau_f$ coefficient estimates (which represent average effects over one, two or three years) as years unfold suggests a higher and permanent adjustment takes place over time. Moreover, the observed magnitudes are economically meaningful: An importer at the 90^{th} percentile of the distribution of the tax exposure reduces its import intensity 1.26 percentage points on average, by 2014.[24]

Consistent with the observed decrease in the imported goods as a fraction of sales, firms directly-exposed to the tax increase their sourcing of domestic inputs. This is illustrated in the middle panel of Table 5, where the outcome variable is defined as the change in the ratio of domestic purchases to sales. The coefficients of interest are positive and statistically significant at the 1%-level in all the specifications, and their magnitude increases in the third year. The estimates suggest that an importer at the 90th percentile of the distribution of the RUSF exposure increased its domestic input intensity by about half of a percentage point.

Finally, the results in the bottom panel of Table 5 indicate that firms directly exposed to the policy shock increased the number of new domestic suppliers. A new domestic supplier is defined as one from which the firm in question did not make any purchases during in $t = -1$ or $t = 0$ (i.e., in 2010 or 2011). The adjustment process begins in year 2012 following the shock and continues

[24] Note that, in the data, the average value of imports to sales ratio is 3.2%.

increasingly over time. In all three columns, the estimates are statistically significant at the one percent level. Finding new domestic suppliers is likely to take time, as RUSF-impacted buyers consider their options, let the current import contracts run their course, consider the quality versus price tradeoff of domestic substitutes, and potentially factor in the eventuality that the RUSF shock is indeed permanent.

As in the case of the baseline results, we conduct two placebo checks analogous to those described above. As expected, these two sets of placebo exercises do not produce any statistically significant results (see Table A3).

4.3 Network effects of the RUSF shock

Next, we examine whether the RUSF tax increase related effects propagate beyond the directly-exposed firms, after controlling for the direct effects. We do this by estimating regression equation (7). Our dependent variable is again the log change in firm-level sales. The results, presented in Table 6, follow the format of the earlier tables in that columns 1, 2 and 3 correspond to changes in log sales from 2011 to 2012, 2011 to 2013, and 2011 to 2014, respectively.

Three observations emerge from Table 6. First, we confirm our previous finding of a negative short-term effect of the tax increase on the sales growth of the directly-exposed firms. The magnitude of the coefficient estimate for $\Delta \ln \tau_f$ in 2012 (column 1) is equal to a statistically significant -11.69 that is almost identical to the one in column 1 of Table 2 (in which the network effects are not accounted for). As before, this effect is short-lived as it is statistically significant only in 2012 but not in later years.

Second, and importantly, we find evidence of a downward 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 affected by the shock if their suppliers are exposed to the RUSF increase, irrespective of whether they are directly impacted by the tax increase or not. 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). We find that the observed effect is again short-lived: The estimated coefficient on $\Delta \ln \tau_f^{Suppliers}$ is equal to -13.86, and statistically significant (at the 1%-level) only in the year $t = 1$ following the shock (i.e., in year 2012). Its magnitude is slightly larger than the magnitude of the direct effect, suggesting that the effect of the RUSF shock on sales gets amplified while it is being transmitted through the affected suppliers in the economy. If we assume a price elasticity of sales of 9.65 (as before), we obtain an estimate of the pass-through rate of tax to prices equal to 1.6, as compared to 1.36 for the direct effect. In columns 2 and 3, we look at the cumulative effect over two or three years after RUSF increase. The estimated coefficients for $\Delta \ln \tau_f^{Suppliers}$ over two or three years become smaller and are not statistically significant.

Third, we find no evidence of upstream propagation of the shock from the exposed buyers to their suppliers. The coefficient on $\Delta \ln \tau_f^{Buyers}$ is small and not statistically significant in any of the empirical specifications presented in Table 6. The result that the RUSF shock propagates through firms' affected-suppliers but not through their affected-buyers is in line with Acemoglu, Akcigit, and Kerr (2016).

In another exercise, presented in Table A4, we consider the sum of both first and second degree linkages in the production network, as defined in equations (2)-(4). The results confirm the conclusions from Table 6. As one would expect, the cumulative first- and second-order linkages lead to slightly larger magnitude for the suppliers' estimated coefficient in year $t = +1$. The same explanatory variable's coefficient estimate remains small and statistically insignificant when we examine two or three year cumulative effects in columns 2 and 3 of Table A4. The coefficient estimate for the first- and second-order transmission of the RUSF shock through *buyers* remains small in size and statistically insignificant in all of the columns of Table A4.

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, and (ii) indirectly via their suppliers. Moreover, we find that the impact of the shock as it travels downstream through the production network is comparable to the direct effect on exposed firms. However, we find no empirical evidence that the RUSF shock travels upstream neither in the short-run (i.e., in one year), nor in the longer-run (i.e., in two to three years). These findings are consistent with the predictions of Acemoglu, Akcigit, and Kerr (2016). We conclude that even small cost-push shocks can propagate and get magnified through the production networks.[25]

5 Role of Liquidity Constraints

The results of Section 4 indicate that a relatively small but unexpected input-cost shock, in the form of RUSF increase, can have a non-trivial impact on firms' sales through both direct (own-exposure) and indirect (suppliers' exposures) channels. We also find that the RUSF shock's negative effects are short-lived for sales (Tables 4 and 6) as the affected firms switch to domestic input substitutes and their suppliers eventually (Table 5).

That said, it is unlikely that all firms be affected the same way by the input-cost shock: To the extent their financial condition 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 be able to do so, such firms should cease importing based on international trade credit terms that expose them to the RUSF import levy. Given the unexpected nature of the tax increase, it makes economic sense that the way firms would avoid (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 on 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 the framework presented below, we focus on firm's sales to other firms, as this is what we can observe in data. In subsection 5.2, we test these predictions and confirm that firms' liquidity constraints indeed amplify the impact of the shock, and this for both direct and indirect (suppliers') channels.

[25] In other regressions (available upon request), we examine the effect of indirect exposure on firms' growth of costs. These additional regressions are in line with our sales growth results: They show an increase in costs in $t = +1$ through own and supplier exposures, but not through exposures to buyers.

5.1 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.

5.1.1 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:

$$Q_f = A_f K_f^{\alpha} L_f^{\beta} \Pi_{v=1}^{N} \left(X_{f,v}\right)^{\gamma_v} \tag{8}$$

where, A_f is the firm-specific productivity shifter; K_f denotes the capital input needed for the production, L_f the labor input, $X_{f,v}$ the composite input variety v used by firm f (see equation 9 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:

$$X_{f,v} = \left(a^{\frac{1}{\varepsilon_X}} \left(X_{f,v}^{F}\right)^{\frac{\varepsilon_X - 1}{\varepsilon_X}} + (1-a)^{\frac{1}{\varepsilon_X}} \left(X_{f,v}^{H}\right)^{\frac{\varepsilon_X - 1}{\varepsilon_X}} \right)^{\frac{\varepsilon_X}{\varepsilon_X - 1}} \tag{9}$$

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

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

$$X_{f,v}^{F} = \left(\sum_{k}^{N_{F,v}} \left(b_{f,v,k}^{F}\right)^{\frac{1}{\varepsilon_F}} \left(x_{f,v,k}^{F}\right)^{\frac{\varepsilon_F - 1}{\varepsilon_F}} \right)^{\frac{\varepsilon_F}{\varepsilon_F - 1}},$$

$$X_{f,v}^{H} = \left(\sum_{l}^{N_{H,v}} \left(b_{f,v,l}^{H}\right)^{\frac{1}{\varepsilon_H}} \left(x_{f,v,l}^{H}\right)^{\frac{\varepsilon_H - 1}{\varepsilon_H}} \right)^{\frac{\varepsilon_H}{\varepsilon_H - 1}}$$

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.[26] The elasticities of substitution among foreign and domestic inputs are respectively ε_F and ε_H with $b_{f,v,k}^{F} \geq 0$ and $b_{f,v,l}^{H} \geq 0$.

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

$$c_f = \frac{R^{\alpha} w^{\beta} \Pi_{v=1}^{N} \left(P_{f,v}\right)^{\gamma_v}}{A_f \left(\alpha\right)^{\alpha} \left(\beta\right)^{\beta} \Pi_{v=1}^{N} \left(\gamma_v\right)^{\gamma_v}} \tag{10}$$

where, R is the cost of capital, w is the wage, and $P_{f,v}$ – the cost of the composite intermediate (a function of domestic and foreign intermediate prices) – is defined by equation (21) 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, $p_f = c_f$.[27]

5.1.2 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 $r_f \times p_{f,v,k}^{F}$, where $p_{f,v,k}^{F}$ 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 $\tau_0 \times p_{f,v,k}^{F}$. 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

[26] Note that the notation v, k (v, l) denotes a particular sub-variety of v of the foreign (home) kind.

[27] 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.

intermediate through bargaining with their international suppliers *before the shock* (i.e., at $t = -1$). 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.[28]

5.1.3 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 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, 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:

$$\frac{d \ln c_f}{d\tau} \Delta\tau = (\tau_1 - \tau_0) \sum_{v \in N_\tau} \gamma_v \frac{1}{\tau_0} \eta^F_{f,v} \tag{11}$$

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

[28] 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.

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

$$(r_f - \tau_0) \sum_{v \in N_\tau} \gamma_v \frac{1}{\tau_0} \eta^F_{f,v} \tag{12}$$

In both expressions (11) and (12), 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 the summation $\sum_{v \in N_\tau} \gamma_v \frac{1}{\tau_0} \eta^F_{f,v}$. 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.

5.1.4 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 (8), firm f will spend a constant fraction γ_v of its input purchases on composite input v:

$$P_{f,v} X_{f,v} = \gamma_v p_f Q_f \tag{13}$$

which can be re-written as

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

where, $\eta^H_{f,v} = 1 - \eta^F_{f,v}$, is the share of domestic varieties in material inputs, whereas $\chi_{f,v,l}$ is the share of the particular domestic sub-variety l of input v in the expenditures on domestic intermediates for composite input v, while $x^H_{f,v,l}$ denote the quantity of home (H) input v's sub-variety l used in the production of firm f's (only) output, and $p^H_{f,v,l}$ is its price.[29]

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

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

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:

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

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

$$\mathbf{pQ} = (\mathbf{I} - \boldsymbol{\Xi})^{-1} \zeta Y, \tag{14}$$

where $\boldsymbol{\Xi}$ 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 $(\mathbf{I} - \boldsymbol{\Xi})^{-1}$ in (14) 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 RUSF levy on sales), let us consider a first-round approximation of firm sales based on the approximation of the inverse proposed by Waugh (1950). If firm f were the first firm, the sales are then given by:

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

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 $p_f \equiv p_{g,v,f}^{H}$, 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:

$$\frac{\partial\left(p_f Q_f\right)}{\partial \tau} = Y\left(\sum_{g\neq f}\zeta_g\gamma_v\left[\eta^H_{g,v}\frac{\partial\chi_{g,v,f}}{\partial p_f}+\chi_{g,v,f}\frac{\partial\eta^H_{g,v}}{\partial p_f}\right]+\frac{\partial\zeta_f}{\partial p_f}\right)\frac{\partial p_f}{\partial\tau} \tag{15}$$

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., $\frac{\partial\chi_{g,v,f}}{\partial p_f}\frac{\partial p_f}{\partial\tau}$), the general change in the usage of domestic and foreign intermediates (captured by the terms $\frac{\partial\eta^H_{g,v}}{\partial p_f}\frac{\partial p_f}{\partial\tau}$), 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 $\varepsilon_X > 1$.[30] There is a negative effect on the firm's production costs due to the increase in the input prices (due to the RUSF levy). Then, since cost increases are fully transmitted by the firms into their output's prices, $\frac{\partial\chi_{g,v,f}}{\partial p_f} < 0$ as firm f's buyers will substitute away from f's variety towards other domestic varieties (see equation 30). 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 $\frac{\partial\eta^H_{g,v}}{\partial p_f} < 0$ (equation 31). 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 subjected to RUSF, firms with high costs of credit 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.

Proposition 1 *Suppose $\varepsilon_H > 1$ and $\varepsilon_X > 1$. The impact of a RUSF change on firms' sales is negative for firms using international trade financing subjected 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 subjected to RUSF,*

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

[30] The estimation of ε_X in Section (??) yields $\varepsilon_X \in (1.7, 1.9)$ and we assumed throughout $\varepsilon_H = 9.65$. If, for example, $\varepsilon_H = 1$ and $\varepsilon_X = 1$, then there would be no effect on sales as the shares in input (and final demand) expenditures on particular domestic sub-varieties do not change.

Proof. See Appendix A. ■

Another relevant cost channel operates through domestic suppliers that relied on the international trade financing that is subjected 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 and a pass-through to the buyer's costs that in turn affects buyer's sales.[31] 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 firms' 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 are exposed to RUSF-subjected international trade financing of foreign intermediates.*

Proof. See Appendix A. ■

If, as assumed $\varepsilon_X = \varepsilon_Q$ then the effect on suppliers' sales from buyers affected by RUSF (upstream propagation of the shock) is zero (see Section A.3.1 in the Appendix) as the subsitution of buyers' demand towards domestic intermediates and the concommitant negative effect on buyer's sales balance out.

5.2 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, whereas (ii) liquidity-constrained firms will continue to rely on international trade financing that is subjected to RUSF despite its higher cost after the shock. Liquidity-constrained firms will be more affected by the RUSF levy increase. We define liquidity constrained

[31]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, as presented in Table 6, this channel is not detectable.

firms ($Liquidity^{Low}_{f,t=-1}$) as those that are below the median liquidity measure for their industry (defined as one of the 22 2-digit-level NACE sectors) in the year prior to the shock. We use the, so-called, quick ratio as our liquidity measure: i.e., the ratio of the sum of cash and marketable securities (i.e., cash equivalents) plus accounts receivable to current liabilities.[32, 33]

We augment our estimating equation (7) by adding the above-defined low-liquidity indicator variable ($Liquidity^{Low}_{f,t=-1}$), as well as its interaction with the variables capturing the direct and indirect exposure to the RUSF shock. Given our earlier results, we focus only on the impact in the year immediately following the shock. The results presented in Table 7 confirm our prediction that financial constraints, in the form of liquidity constraints, play a role in economic shocks' transmission. The estimates suggest that the impact of the shock on the low-liquidity firms is more than 150% higher than its impact on high-liquidity firms: an additional impact of −9.295 for low-liquidity in comparison to the base case for high-liquidity firms (with all estimates being statistically significant at the 10%-level). This finding continues to hold true in column 2 of Table 7, in which we allow for upstream and downstream network effects (as in column 1 of Table 6, firm's indirect exposure through its exposed suppliers continues to have a negative effect on its sales, albeit with a somewhat lower yet statistically significant coefficient). In the final specification (column 3), we allow for the interactions between the low-liquidity indicator ($Liquidity^{Low}_{f,t=-1}$) and the indirect effects coming from suppliers and buyers. Although the estimates for these interactions are negative, they are not statistically significant.[34]

In Table 8, we turn our attention to the potential role of liquidity constraints faced by the suppliers and buyers of the firm on its sales growth. 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 ($Exposure^{Suppliers,HighLiq}_{f,t=-1}$, $Exposure^{Suppliers,LowLiq}_{f,t=-1}$) and do the same for buyers ($Exposure^{Buyers,HighLiq}_{f,t=-1}$, $Exposure^{Buyers,LowLiq}_{f,t=-1}$). The estimates of the empirical model that in-

[32]We obtain very similar results if we define the liquidity ratio as a fraction of total assets: i.e., as the ratio of cash, marketable securities, and accounts receivables to total assets. See Almeida, Campello, and Weisbach (2004) for different measures of corporate liquidity.

[33]The unconditional correlation between *Exposure* and *QuickRatio* is 0.027. For conditional correlations, we regress $Exposure_f$ on *QuickRatio*, both calculated as of $t = -1$. The estimated coefficient on *QuickRatio* is economically and statistically insignificant. The result is robust to controlling for firm size.

[34]One might be concerned about liquidity being correlated with firm leverage and size. However, as illustrated in Table A5, interactions with indicators for higher-than-industry-median leveraged firms or firms with lower-than-industry-median size do not produce statistically significant results.

cludes the latter variables are presented in column 1 of Table 8. These results suggest that the indirect effect is much larger when it comes from suppliers with low liquidity: the coefficient estimate for $Exposure_{f,t=-1}^{Suppliers,LowLiq}$ is equal to -18.89, whereas the one for $Exposure_{f,t=-1}^{Suppliers,HighLiq}$ is equal to -10.69, with both coefficient estimates being statistically significant at the 1%-level. The difference between the two effects is statistically significant as well.[35]

Next, we investigate the interplay between own-liquidity constraints and the liquidity constraints of the firm's up- and down-stream counterparts. To increase the readability of the results, we split the main sample into high-own- and low-own-liquidity firms.[36] The results are presented in columns 2 and 3 of Table 8, respectively. Consistent with the results in Table 7, we find that the direct effect is smaller for high-liquidity firms (the coefficient estimate of $\Delta \ln \tau_f$ is equal to -6.084 in column 2) compared to less-liquidity constrained firms (-15.53 in column 3). More interestingly, our evidence is consistent with the idea that high-liquidity firms propagate the shock less. First, column 2 of Table 8 shows that that high-own liquidity firms are affected less via their suppliers, and this irrespective of their suppliers liquidity classification, than low-own liquidity firms. The coefficient estimates for $\Delta \ln \tau_f^{Suppliers,HighLiq}$ and $\Delta \ln \tau_f^{Suppliers,LowLiq}$ are lower in column 2 than they are in column 3. In fact, in column 2 for high-own liquidity (i.e., liquidity unconstrained) firms, there is no statistically significant difference between the effect of low- and high-liquidity suppliers (with the estimates being -11.140 and -9.311, respectively), and both effects are smaller in magnitude compared to those found in the full sample (-18.89 and -10.69 in column 1 of Table 8, respectively) and in the low-own liquidity subsample (-20.03 and -10.914 in column 3 of Table 8, respectively). This pattern is consistent with high-own liquidity firms extending credit to their financially-constrained suppliers hit by the tax increase (that said, in the absence of domestic trade-finance data, we cannot provide a direct test of this conjecture). These results contrast sharply with those in column 3 of Table 8, which suggests that low-own liquidity firms are greatly affected via the liquidity-constrained suppliers. Finally, we fail to find any evidence that would suggest that the RUSF shock propagated upstream. In Table 8, none of the coefficient estimates for $\Delta \ln \tau_f^{Buyers,LowLiq}$ and $\Delta \ln \tau_f^{Buyers,LowLiq}$ are statistically significant.

Summarizing, the results in this subsection support the theoretical predictions of our simple

[35]Note that there is no statistically significant difference between how small and large suppliers propagate the shock (see Table A6).

[36]As before, the liquidity constraint threshold is defined with respect to each firm's industry's median.

theory framework. They are also consistent with the view that liquidity-constrained firms magnify and propagate the perturbation downstream.

6 Conclusions

This paper examines whether a small cost-push shock propagates in a production chain, and if it does, what its short- and medium-run effects are on the firms in the network. To identify the effects of the supply-shock, we use an unexpected policy change in Turkey that increased the price of foreign-credit financed imports from 3% to 6% overnight. Given that the said import tax is based on the type of international trade financing used, the policy change had a heterogenous 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 this relatively small shock 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 tests show that the directly exposed-firms switch to local suppliers. Moreover, this switch is not limited to the short-term as it holds for the three years after the policy change. Third, the input-shock propagated downstream as exposed-suppliers passed it onto their customers. Moreover, indirect exposures through suppliers magnify the effects of the import-tax increase over-and-above the effects of the firms' own-exposures. Fourth, propagation of the cost-push shock is amplified especially by liquidity-constrained firms.

Put differently, our findings suggest that even relatively small economic shocks can affect open economies in non-negligible ways. The resulting impact is not limited to direct exposures: indirect exposures through suppliers appear to be equally if not more 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. Interestingly, while the resulting effects on firm performance appear to be short-lived (through increases in costs and decreases in sales in the year that follows the shock), changes in exposed-firms' supplier networks have a longer duration. A likely explanation is 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 5.1.

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:

$$Q_f = A_f K_f^{\alpha} L_f^{\beta} \Pi_{v=1}^{N} X_{f,v}^{\gamma_v} \tag{16}$$

where, A_f is firm-specific productivity shifter; K_f denotes capital input, L_f labor, $X_{f,v}$ is the composite input v used by firm f (equation 17). 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:

$$X_{f,v} = \left(a^{\frac{1}{\varepsilon_X}} \left(X_{f,v}^F \right)^{\frac{\varepsilon_X - 1}{\varepsilon_X}} + (1-a)^{\frac{1}{\varepsilon_X}} \left(X_{f,v}^H \right)^{\frac{\varepsilon_X - 1}{\varepsilon_X}} \right)^{\frac{\varepsilon_X}{\varepsilon_X - 1}} \tag{17}$$

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:

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

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

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

$$\begin{aligned}\widetilde{P}^{F}_{f,v} &= \sum_{k}^{N_{F,v}} \left(p^{F}_{f,v,k}\right)^{1-\varepsilon_F} b^{F}_{f,v,k} \\ \widetilde{P}^{H}_{f,v} &= \sum_{l}^{N_{H,v}} \left(p^{H}_{f,v,l}\right)^{1-\varepsilon_H} b^{H}_{f,v,l}\end{aligned} \tag{18}$$

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

$$\begin{aligned}\sum_{k}^{N_{F,v}} p^{F}_{f,v,k} x^{F}_{f,v,k} &= \left(\widetilde{P}^{F}_{f,v}\right)^{-\frac{1}{\varepsilon_F-1}} X^{F}_{f,v} \\ \sum_{l}^{N_{H,v}} p^{H}_{f,v,l} x^{H}_{f,v,l} &= \left(\widetilde{P}^{H}_{f,v}\right)^{-\frac{1}{\varepsilon_H-1}} X^{H}_{f,v}\end{aligned} \tag{19}$$

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

$$c_f = \frac{R^{\alpha} w^{\beta} \Pi_{v=1}^{N} \left(P_{f,v}\right)^{\gamma_v}}{A_f \left(\alpha\right)^{\alpha} \left(\beta\right)^{\beta} \Pi_{v=1}^{N} \left(\gamma_v\right)^{\gamma_v}}, \tag{20}$$

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

$$P_{f,v} = \left(a\left(\widetilde{P}^{F}_{f,v}\right)^{\frac{\varepsilon_X-1}{\varepsilon_F-1}} + (1-a)\left(\widetilde{P}^{H}_{f,v}\right)^{\frac{\varepsilon_X-1}{\varepsilon_H-1}}\right)^{\frac{1}{1-\varepsilon_X}}. \tag{21}$$

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 $r_f \times p^{F}_{f,v,k}$, where $p^{F}_{f,v,k}$ 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 $\tau_0 \times p^{F}_{f,v,k}$. 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 $t = -1$). 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 (20) and letting Γ be a collection of parameters, we obtain:

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

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 $P_{f,v}$ is (approximately):

$$\frac{d \ln c_f}{d\tau} \Delta\tau = (\tau_1 - \tau_0) \sum_{v \in N_\tau} \gamma_v \frac{1}{\tau_0} \eta^F_{f,v} \tag{22}$$

where $\eta^F_{f,v} = \frac{a\left(\widetilde{P}^F_{f,v}\right)^{\frac{1-\varepsilon_X}{1-\varepsilon_F}}}{\left(a\left(\widetilde{P}^F_{f,v}\right)^{\frac{1-\varepsilon_X}{1-\varepsilon_F}}+(1-a)\left(\widetilde{P}^H_{f,v}\right)^{\frac{1-\varepsilon_X}{1-\varepsilon_H}}\right)}$ 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

$$(r_f - \tau_0) \sum_{v \in N_\tau} \gamma_v \frac{1}{\tau_0} \eta^F_{f,v}. \tag{23}$$

In both expressions (22) and (23), 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 $\sum_{v \in N_\tau} \gamma_v \frac{1}{\tau_0} \eta_{f,v}$. 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:

$$\left(\frac{\partial \ln P_{f,v}}{\partial \tau}\right)_{indirect} \quad = \quad \frac{1}{1-\varepsilon_H} \eta^H_{f,v} \frac{\frac{\partial \widetilde{P}^H_{f,v}}{\partial \tau}}{\widetilde{P}^H_{f,v}} \tag{24}$$

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

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

In our simple framework, firms do not charge mark-ups, and any changes in their costs are reflected in their prices so that $\frac{\partial p^H_{f,v,l}}{\partial \tau} = \frac{\partial c_{f,v,l}}{\partial \tau}$. 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 (22) and (23).

Combining all above elements into equation (24), 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:

$$\sum_{v=1}^{N} \gamma_v \frac{1}{\tau_0} \eta_{f,v}^{H} \left\{ \begin{array}{l} \left[(\tau_1 - \tau_0) \sum_{l \notin \Theta_{f,v}} \chi_{f,v,l} \left(\sum_{q \in N_{\tau,l}} \gamma_q \eta_{l,q}^{F} \right) \right] \\ + \left[\sum_{l \in \Theta_{f,v}} (r_l - \tau_0) \chi_{f,v,l} \left(\sum_{q \in N_{\tau,l}} \gamma_q \eta_{l,q}^{F} \right) \right] \end{array} \right\} \tag{25}$$

where $\Theta_{f,v}$ denotes, for firm f and input variety v, the set of suppliers that face low liquidity costs, i.e., $r_f < r*$, and $\chi_{f,v,l} = \frac{p_{f,v,l}^{H} x_{f,v,l}^{H}}{\sum p_{f,v,k}^{H} x_{f,v,k}^{H}} = \frac{b_{f,v,l}^{H} \left(p_{f,v,l}^{H} \right)^{1-\varepsilon_H}}{\tilde{P}_{f,v}^{H}}$, 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 (16) for firm f, the firm will spend a constant fraction of its input expenditures on input v:

$$P_{f,v} X_{f,v} = \gamma_v p_f Q_f, \tag{26}$$

which can be re-written as

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

where $\chi_{f,v,l} = \frac{\left(p_{f,v,l}^{H} \right)^{1-\varepsilon_H} b_{f,v,l}^{H}}{\sum \left(p_{f,v,k}^{H} \right)^{1-\varepsilon_H} b_{f,v,k}^{H}} = \frac{p_{f,v,l}^{H} x_{f,v,l}^{H}}{\sum p_{f,v,k}^{H} x_{f,v,k}^{H}}$ 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:

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

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

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

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

$$\mathbf{pQ} = (\mathbf{I} - \mathbf{\Xi})^{-1} \zeta Y, \tag{27}$$

where $\mathbf{\Xi}$ 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 $(\mathbf{I} - \mathbf{\Xi})^{-1}$ in (27) 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:

$$p_1 Q_1 = \begin{bmatrix} 1 & \eta_{2,v}^{H} \chi_{2,v,f} \gamma_v & \ldots & \eta_{n,v}^{H} \chi_{n,v,f} \gamma_v \end{bmatrix} \zeta Y \tag{28}$$

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 $p_f \equiv p_{g,v,f}^{H}$, is given by:

$$\frac{\partial (p_f Q_f)}{\partial \tau} = Y \left(\sum_{g \neq f} \zeta_g \gamma_v \left[\eta_{g,v}^{H} \frac{\partial \chi_{g,v,f}}{\partial p_f} + \chi_{g,v,f} \frac{\partial \eta_{g,v}^{H}}{\partial p_f} \right] + \frac{\partial \zeta_f}{\partial p_f} \right) \frac{\partial p_f}{\partial \tau} \tag{29}$$

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) $\frac{\partial \chi_{g,v,f}}{\partial p_f}\frac{\partial p_f}{\partial \tau}$ and their general change in the usage of domestic intermediates captured by the terms $\frac{\partial \eta^H_{g,v}}{\partial p_f}\frac{\partial p_f}{\partial \tau}$. 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 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 (15) 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,

$$\frac{\partial \chi_{g,v,f}}{\partial p^H_{g,v,f}} = \frac{(1-\varepsilon_H)}{p^H_{g,v,f}}\chi_{g,v,f} \tag{30}$$

$$\frac{\partial \eta^H_{g,v}}{\partial p^H_{g,v,f}} = \frac{(1-\varepsilon_X)}{p^H_{g,v,f}}\eta^H_{g,v}\eta^F_{g,v}\chi_{g,v,f} \tag{31}$$

$$\frac{\partial \zeta_f}{\partial p_f} = (1-\varepsilon_H)\frac{\partial p_f}{\partial \tau}(p_f)^{-1}\zeta_f. \tag{32}$$

Combining (30) – (32) with expressions for the change in the marginal cost equation (15) we obtain:

$$\Delta F\frac{\partial (p_f Q_f)}{\partial \tau} = \Delta F(1-\varepsilon_H)Y\left(\sum_{\nu\in N_\tau}\frac{\gamma_\nu}{\tau_0}\eta^F_{f,\nu}\right)\left(\sum_{g\neq f}\zeta_g\gamma_v\eta^H_{g,v}\chi_{g,v,f}\left[1+\frac{(1-\varepsilon_X)}{(1-\varepsilon_H)}\eta^F_{g,v}\right]+\zeta_f\right) \tag{33}$$

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 (33) 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 $\eta_{g,v}^F$ is small.

$$\frac{\partial\left(p_f Q_f\right)}{\partial \tau}\frac{\tau}{p_f Q_f} \approx \left(1-\varepsilon_H\right)\frac{\partial p_f}{\partial \tau}\frac{\tau}{p_f} \tag{34}$$

A.3.2 Effects of RUSF through suppliers' costs

Proof of Proposition 2

Given the derivations in Section A.3.1 – equations (30) and (31) – 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 (25). 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, $\eta_{f,v}^H$ (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. (28) 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

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

and the resulting elasticity is $\left[-\left(1-\varepsilon_X\right)\eta_{2j}+\left(1-\varepsilon_Q\right)\sum_{k\in N_2}\gamma_k\eta_{2k}\right]$. If, as assumed $\varepsilon_X=\varepsilon_Q$ then the two effects cancel out and the effect from buyers affected by RUSF (upstream propagation of the shock) should be zero.

B Tables and Graphs

Table 1: **Summary Statistics for Own Exposure**

	Variable		
	Import intensity	$Exposure^M$	$Exposure$
	Importers		
Mean	0.150	0.170	0.024
Median	0.098	0.124	0.009
$75th$ pctile	0.250	0.236	0.029
$95th$ pctile	0.450	0.450	0.099
Std dev	0.150	0.167	0.041
Number of firms	14,473	14,473	14,473
	All firms		
Mean	0.028	0.038	0.005
Median	0	0	0
$75th$ pctile	0	0	0
$95th$ pctile	0.233	0.253	0.033
Std dev	0.088	0.106	0.022
Number of firms.	69,293	69,293	69,293

Notes: This table decomposes firm's own-exposure to the RUSF shock (in the third column) into two components: (i) firm's import intensity, i.e., the share of imported inputs in firm's variable costs (in the first column), and (ii) share of firm's imports subject to the RUSF tax ($Exposure^M$ in the second column). The decomposition directly follows from equation (1) as follows:

$$\begin{aligned}
Exposure_{f,t=-1} &= \sum_j \omega_{f,j,t=-1} \times Exposure_{j,t=-1} \\
&= \sum_j \frac{M_{f,j,t=-1}}{TotalCosts_{f,t=-1}} \times Exposure_{j,t=-1} \\
&= \sum_j \frac{M_{f,j,t=-1}}{TotalCosts_{f,t=-1}} \times \frac{M_{f,t=-1}}{M_{f,t=-1}} Exposure_{j,t=-1} \\
&= \underbrace{\frac{M_{f,t=-1}}{TotalCosts_{f,t=-1}}}_{\text{Import intensity}} \underbrace{\overbrace{\sum_j \frac{M_{j,f,t=-1}}{M_{f,t=-1}} Exposure_{j,t=-1}}^{Exposure^M_{f,t=-1}}}_{\text{Share of firm's imports subject to RUSF}}
\end{aligned}$$

Table 2: **Summary Statistics for Buyer and Supplier Exposure**

	Variable		
	$Exposure$	$Exposure^{Suppliers}$	$Exposure^{Buyers}$
		Importers	
Mean	0.024	0.009	0.011
Median	0.009	0.006	0.006
$75th$ pctile	0.029	0.012	0.014
$95th$ pctile	0.099	0.030	0.099
Std dev	0.041	0.030	0.038
Number of firms	14,473	14,473	14,473
		All firms	
Mean	0.005	0.006	0.007
Median	0	0.001	0.001
$75th$ pctile	0	0.007	0.008
$95th$ pctile	0.033	0.030	0.034
Std dev	0.022	0.014	0.017
Number of firms.	69,293	69,293	69,293

Table 3: **Direct Effect of the Shock on Firms' Switches of Payment Terms**

Dependent variable: $Exposure^{Actual}_{f,t=1} - Exposure^{Actual}_{f,t=0}$	(1)	(2)
$Exposure^{Actual}_{f,t=-1}$	**-0.205*****	
	(0.009)	
$Exposure_{f,t=-1}$		**-0.236*****
		(0.023)
R^2	0.094	0.054
N	17,746	17,746
Fixed effects	i-r	i-r

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. $Exposure^{Actual}_{f,t=-1}$ is the actual share of RUSF-affected imports of the firm in 2010. $Exposure_{f,t=-1}$ is defined in equation (1). The fixed-effects are at the industry-region (i-r) 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 4: **Direct Effect of the Shock on Firm-level Sales**

	(1)	(2)	(3)
Dependent variable:	$(\ln Sales_{f,t=1} - \ln Sales_{f,t=0})$	$(\ln Sales_{f,t=2} - \ln Sales_{f,t=0})$	$(\ln Sales_{f,t=3} - \ln Sales_{f,t=0})$
$\Delta \ln \tau_f$	**-11.73*****	-4.421	4.649
	(2.474)	(3.230)	(7.103)
R^2	0.0191	0.0248	0.0245
N	69,293	69,293	69,293
Fixed effects	i-r	i-r	i-r

Notes: This table shows the results from estimating specification in equation (6) where the dependent variable is the growth rate of sales of firm f operating in industry i and located in region r between (in column 1) 2011-2012, (2) 2011-2013, and (3) 2011-2014. τ_f captures the firm-level effective tax rate, as defined in equation (5a). The 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 level.

Table 5: **Direct Effect of the Shock on Firm-level Input Purchases**

	(1)	(2)	(3)
Dependent variable:	$(\frac{M}{Sales}_{f,t=1} - \frac{M}{Sales}_{f,t=0})$	$(\frac{M}{Sales}_{f,t=2} - \frac{M}{Sales}_{f,t=0})$	$(\frac{M}{Sales}_{f,t=3} - \frac{M}{Sales}_{f,t=0})$
$\Delta \ln \tau_f$	**-13.98*****	**-17.98*****	**-22.06*****
	(1.343)	(1.691)	(1.653)
R^2	0.0232	0.0246	0.0344
Dependent variable:	$(\frac{DomPurch}{Sales}_{f,t=1} - \frac{DomPurch}{Sales}_{f,t=0})$	$(\frac{DomPurch}{Sales}_{f,t=2} - \frac{DomPurch}{Sales}_{f,t=0})$	$((\frac{DomPurch}{Sales}_{f,t=3} - \frac{DomPurch}{Sales}_{f,t=0})$
$\Delta \ln \tau_f$	**7.265*****	**7.240*****	**9.005*****
	(0.093)	(0.130)	(0.069)
R^2	0.0242	0.0323	0.0566
Dependent variable:	$(NewDomSupp_{f,t=1} - NewDomSupp_{f,t=0})$	$(NewDomSupp_{f,t=2} - NewDomSupp_{f,t=0})$	$((NewDomSupp_{f,t=3} - NewDomSupp_{f,t=0})$
$\Delta \ln \tau_f$	**217.1*****	**249.2*****	**267.4*****
	(36.66)	(43.58)	(55.64)
R^2	0.0292	0.0307	0.0369
N	69,293	69,293	69,293
Fixed effects	i-r	i-r	i-r

Notes: This table shows the results from estimating specification in equation (6) where the dependent variable is the change in imports to sales ratio (upper panel), change in domestic purchases to sales ratio (middle panel) and new domestic supplier links of firm f operating in industry s and located in region r at time $l = \{2012, 2013, 2014\}$ (lower panel). τ_f captures the firm-level effective tax rate, as defined in equation (5a). The 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 6: **Direct and Indirect Effects of the Shock on Firm-level Sales**

	(1)	(2)	(3)
Dependent variable:	$(\ln Sales_{f,t=1} - \ln Sales_{f,t=0})$	$(\ln Sales_{f,t=2} - \ln Sales_{f,t=0})$	$(\ln Sales_{f,t=3} - \ln Sales_{f,t=0})$
$\Delta \ln \tau_f$	**-11.69*****	-2.969	6.891
	(2.489)	(2.497)	(10.65)
$\Delta \ln \tau_f^{Suppliers}$	**-13.86*****	-4.228	-4.745
	(3.815)	(3.731)	(9.703)
$\Delta \ln \tau_f^{Buyers}$	-2.060	-1.055	0.163
	(1.810)	(2.531)	(4.413)
R^2	0.0194	0.0244	0.0242
N	69,293	69,293	69,293
Fixed effects	sr	sr	sr

Notes: This table shows the results from estimating specification in equation (6) augmented with buyer and supplier effective tax changes. The dependent variable is the growth rate of sales of firm f operating in industry s and located in region r between 2011 and $l = \{2012, 2013, 2014\}$. τ_f captures the firm-level effective tax rate, as defined in equation (5a). The indirect tax variables are defined in equations (5b), and (5c)). The 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 7: **Role of Financial Constraints**

	(1)	(2)	(3)
Dependent variable:	$(\ln Sales_{f,t=1} - \ln Sales_{f,t=0})$	$(\ln Sales_{f,t=2} - \ln Sales_{f,t=0})$	$(\ln Sales_{f,t=3} - \ln Sales_{f,t=0})$
$\Delta \ln \tau_f$	**-6.170***	**-6.385***	**-6.278***
	(3.396)	(3.402)	(3.394)
$Liquidity^{Low}_{f,t=-1}$	**0.0297*****	**0.0287*****	**0.0323*****
	(0.00325)	(0.00341)	(0.00345)
$\Delta \ln \tau_f \times Liquidity^{Low}_{f,t=-1}$	**-9.297***	**-8.909***	**-8.764***
	(5.063)	(5.030)	(5.016)
$\Delta \ln \tau_f^{Suppliers}$		**-11.28*****	**-12.32*****
		(3.754)	(4.832)
$\Delta \ln \tau_f^{Buyers}$		-1.854	-1.411
		(1.821)	(1.563)
$\Delta \ln \tau_f^{Suppliers} \times Liquidity^{Low}_{f,t=-1}$			-1.663
			(5.503)
$\Delta \ln \tau_f^{Buyers} \times Liquidity^{Low}_{f,t=-1}$			-2.470
			(5.987)
R^2	0.0205	0.0206	0.0207
Numb. of obs.	69,293	69,293	69,293
Fixed effects	i-r	i-r	i-r

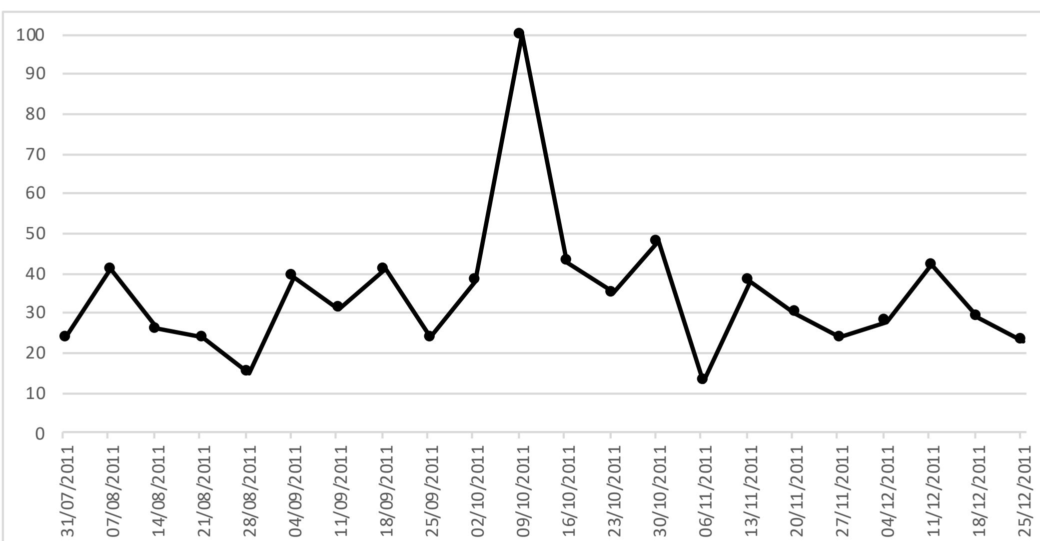
Notes: The dependent variable is the 2011 to 2012 growth rate of sales of firm f operating in industry s and located in region r. τ_f captures the firm-level effective RUSF tax rate exposure as of the year prior to its increase, as defined in equation (5a). The indirect RUSF tax exposure variables are defined as in equations (5b), and (5c)). $Liquidity^{Low}_{f,t=-1}$ is a dummy variable indicating liquidity-constrained firms, which have a quick ratio (defined as the ratio of the sum of cash, marketable securities and accounts receivables to current liabilities) below their industry median at $t = -1$ (i.e., as of year 2010). The 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.e., s-r) level.

Table 8: **Role of financial constraints: Direct and indirect effects**

Dependent variable: ($\ln Sales_{f,t=1} - \ln Sales_{f,t=0}$)	(1)	(2)	(3)
Sample:	Full	High Own-Liquidity	Low Own-Liquidity
$\Delta \ln \tau_f$	**-11.73*****	**-6.084***	**-15.53*****
	(2.485)	(3.366)	(3.633)
$\Delta \ln \tau_f^{Suppliers,LowLiq}$	**-18.89*****	**-11.14***	**-20.03*****
	(5.891)	(6.365)	(5.121)
$\Delta \ln \tau_f^{Suppliers,HighLiq}$	**-10.69*****	**-9.311***	**-10.914*****
	(4.059)	(5.530)	(4.156)
$\Delta \ln \tau_f^{Buyers,LowLiq}$	-3.106	-3.972	0.179
	(2.639)	(2.975)	(7.622)
$\Delta \ln \tau_f^{Buyers,HighLiq}$	-0.347	2.498	-6.587
	(2.225)	(2.352)	(7.384)
R^2	0.0194	0.0283	0.0271
N	69,293	33,383	35,910
Fixed effects	i-r	i-r	i-r
$\beta^{Suppliers,LowLiq} = \beta^{Suppliers,HighLiq}$	**2.865***	0.044	**2.721***

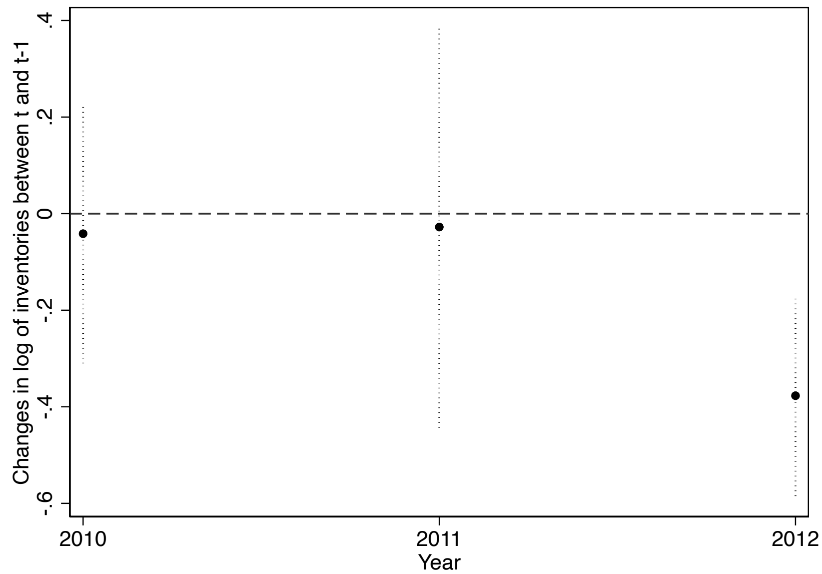
Notes: The dependent variable is the growth rate of sales of firm f operating in industry s and located in region r between 2011 and 2012. τ_f captures the firm-level effective tax rate, as defined in equation (5a). The indirect tax variables are defined in equations (5b), and (5c)). $\tau_f^{Suppliers,HighLiq}$ ($\tau_f^{Buyers,HighLiq}$) denotes the weighted average of liquidity-unconstrained suppliers' (buyers') effective tax rate (i.e. suppliers (buyers) with quick ratio above the industry median as of $T-2$) of firm f. $\tau_f^{Suppliers,LowLiq}$ ($\tau_f^{Buyers,LowLiq}$) denotes the weighted average of liquidity-constrained suppliers' (buyers') effective tax rate (i.e. suppliers (buyers) with quick-ratio below the industry median as of $t=-1$) of firm f. The 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 level.

Figure 1: 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 2: Firm Inventories and Exposure to Shock

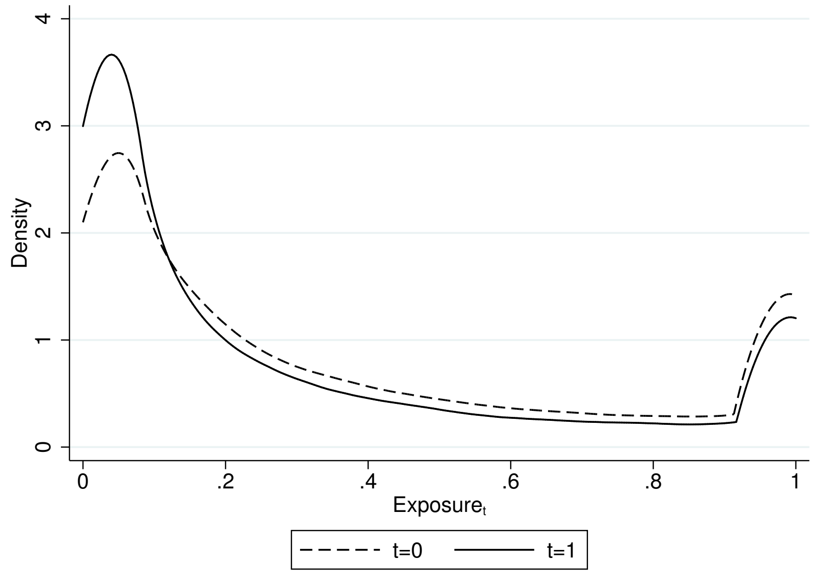


Notes: This figure shows the estimated coefficient (and the associated 95% confidence intervals) on the share of firm-level imports with external financing calculated as of 2010 for different time periods in the following regression equation:

$$\Delta \ln \text{Inventories}_{f,t} = \beta_t \left(\frac{\text{Imports with external financing}}{\text{Total imports}} \right)_f + \alpha_{i,r} + \epsilon_f,$$

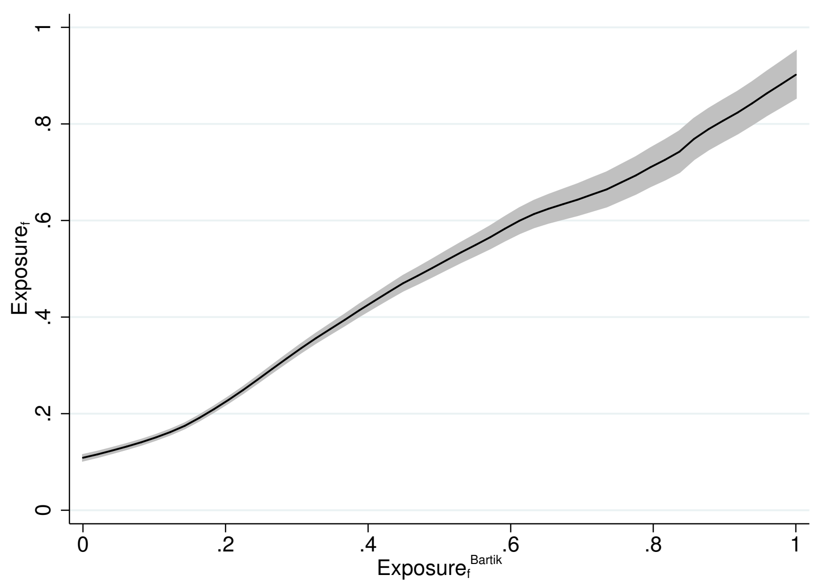
where t denotes the period relative to the date of the policy change; i denotes industries, and r regions.

Figure 3: 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 $t = 0$ can be considered to be the pre-shock period. It covers 4,700 6-digit HS products imported from 150 source countries, amounting to a total number of approximately 75,000 country-product pairs.

Figure 4: Bartik versus Actual Exposure



Notes: This figures shows the local polynomial regression of the share of RUSF-affected imports at the firm level as of $T-2$ constructed using detailed customs data provided by TUIK on the Bartik-type *Exposure* variable defined in equation (1). Slope of the linear regression with sr fixed effects is 0.9(0.021).

Figure 5: Illustration of Network Structure

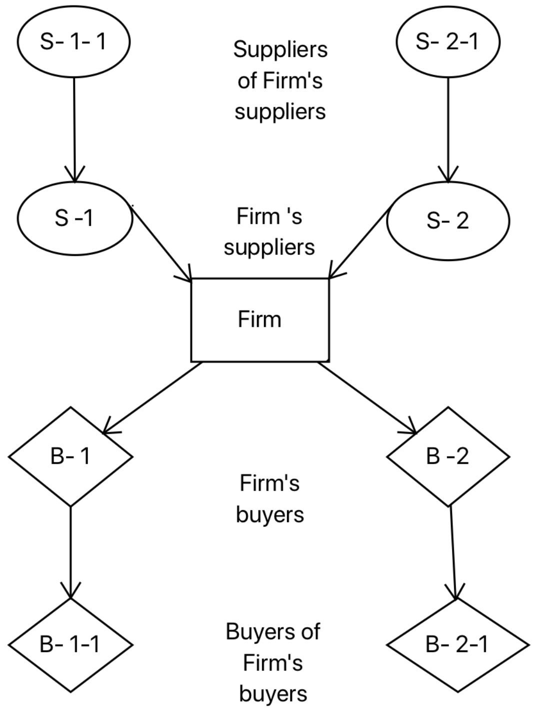
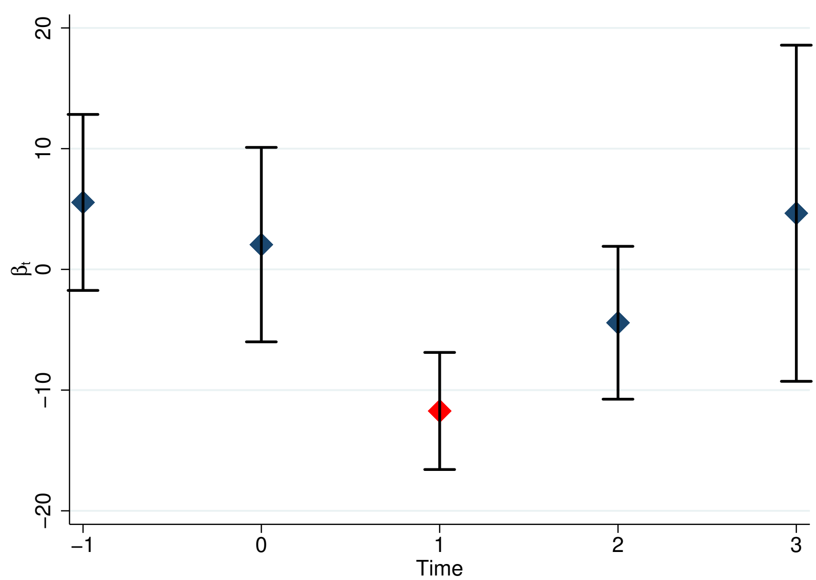


Figure 6: Direct Effect of the Shock on Firm-level Sales: Lags and leads



Notes: This figure shows the estimated coefficient on $\Delta \ln \tau_f$ (and the associated 95% confidence intervals) in equation (6) for different time periods.

Online Appendix Tables

Table A1: **Direct Effect of the Shock on Firm-level Sales: Placebo tests**

	Placebo date	Processing
	$\ln Sales_{f,t=0} - \ln Sales_{f,t=-1}$	$\ln Sales_{f,t=1} - \ln Sales_{f,t=0}$
$\Delta\tau_f = \ln\left(\frac{1+Exposure_{f,t=-2}\times\tau_{t=+1}}{1+Exposure_{f,t=-2}\times\tau_{t=-1}}\right)$	-1.611	
	(2.569)	
$\Delta\tau_f^{Processing} = \ln\left(\frac{1+Exposure_{f,t=-1}^{Processing}\times\tau_{t=+1}}{1+Exposure_{f,t=-1}^{Processing}\times\tau_{t=-1}}\right)$		-2.544
		(11.77)
R^2	0.0264	0.0223
N	65,435	54,636
Fixed effects	s-r	s-r

Notes: This table shows the results from estimating specification in equation (6) where the dependent variable is the growth rate of sales of firm f operating in industry s and located in region r between 2010 and 2011 in column (1), and between 2011 and 2012 in column (2). τ_f captures the firm-level effective tax rate, as defined in equation (5a). $\tau_f^{Processing}$ 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. First column assigns a placebo date (October 2010) to the shock. Second column uses a placebo sample: processing imports, which have not been subject to RUSF. 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 A2: **Direct Effect of the Shock on Firm-level Costs: Robustness checks**

Dependent Variable: $(\ln Sales_{f,t=1} - \ln Sales_{f,t=0})$					
	(1)	(2)	(3)	(4)	(5)
Control variable:	Size	Import int.	Leverage	Loans	All
$\Delta \ln \tau_f$	**-9.012*****	**-9.793*****	**-8.940*****	**-8.969*****	**-9.894*****
	(2.639)	(2.778)	(2.566)	(2.500)	(3.072)
$lnEmp_{f,2010}$	0.001				0.001
	(0.001)				(0.001)
$(M/Sales)_{f,2010}$		0.0101			0.004
		(0.0185)			(0.0200)
$HighLev_{f,2010}$			0.0003		-0.0005
			(0.003)		(0.003)
$HighCredit_{f,2010}$				0.0033	0.0017
				(0.0026)	(0.0027)
R^2	0.0206	0.0204	0.0219	0.0204	0.0221
N	69,293	69,293	69,293	69,293	69,293
Fixed effects	i-r	i-r	i-r	i-r	i-r

Notes: This table shows the results from estimating specification in equation (6) where the dependent variable is the growth rate of sales of firm f operating in industry s and located in region r between 2011 and 2012. τ_f captures the firm-level effective tax rate, as defined in equation (5a). $HighLev$ is a dummy variable indicating whether the firm leverage was above the industry median as of $T-2$. Similarly, $HighCredit$ is a dummy variable indicating whether the firm's total bank loans to assets ratio was above the industry median as of $T-2$. 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 A3: **Direct Effect of the Shock on Firm-level input purchases: Placebo tests**

	(1)	(2)	(3)	(4)	(5)	(6)
		Placebo date $\Delta_{2010-2011}$			Processing imports $\Delta_{2011-2012}$	
	$\left(\frac{\textbf{M}}{\textbf{Sales}}\right)_{\textbf{f}}$	$\left(\frac{\textbf{DomPurch}}{\textbf{Sales}}\right)_{\textbf{f}}$	$\textbf{NewDomSupp}_{\textbf{f}}$	$\left(\frac{\textbf{M}}{\textbf{Sales}}\right)_{\textbf{f}}$	$\left(\frac{\textbf{DomPurch}}{\textbf{Sales}}\right)_{\textbf{f}}$	$\textbf{NewDomSupp}_{\textbf{f}}$
$\ln\left(\frac{1+Exposure_{f,2009}\tau_T}{1+Exposure_{f,2009}\tau_{T-1}}\right)$	-0.928	1.091	6.680			
	(1.173)	(1.253)	(4.480)			
$\ln\left(\frac{1+Exposure^{Processing}_{f,2010}\tau_T}{1+Exposure^{Processing}_{f,2010}\tau_{T-1}}\right)$				-1.050	1.040	6.330
				(6.531)	(4.841)	(20.09)
R^2	0.0146	0.0250	0.0253	0.0220	0.0264	0.0244
N	65,435	65,435	65,435	54,636	54,636	54,636
Fixed effects	sr	sr	sr	sr	sr	sr

Notes: This table shows the results from estimating specification in equation (6) where the dependent variable is the change in imports to sales ratio (columns 1&3) or change in domestic purchases to sales ratio (columns 2&4) of firm f operating in industry s and located in region r in 2010-2011 or 2011-2012. τ_f captures the firm-level effective tax rate, as defined in equation (5a). First three columns assign a placebo date (October 2011) to the shock. Last three columns use a placebo sample: processing imports, which have not been subject to RUSF. 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 A4: **Direct and Indirect Effects of the Shock on Firm-level Sales: Sum of first- and second-degree exposures**

	(1)	(2)	(3)
Dependent variable:	$(\ln Sales_{f,t=1} - \ln Sales_{f,t=0})$	$(\ln Sales_{f,t=2} - \ln Sales_{f,t=0})$	$(\ln Sales_{f,t=3} - \ln Sales_{f,t=0})$
$\Delta \ln \tau_f$	**-11.89*****	-2.980	6.480
	(2.509)	(2.512)	(10.75)
$\Delta \ln \tau_f^{Suppliers}$	**-14.69*****	-4.570	-4.742
	(3.283)	(3.389)	(8.967)
$\Delta \ln \tau_f^{Buyers}$	-2.167	-1.417	0.257
	(1.871)	(1.374)	(1.970)
R^2	0.0195	0.0244	0.0244
N	69,293	69,293	69,293
Fixed effects	sr	sr	sr

Notes: This table shows the results from estimating specification in equation (6) augmented with buyer and supplier effective tax changes. The dependent variable is the growth rate of sales of firm f operating in industry s and located in region r between 2011 and $l = \{2012, 2013, 2014\}$. τ_f captures the firm-level effective tax rate, as defined in equation (5a). The indirect tax variables are defined in equations (5b), and (5c)). We construct them by adding $Exposure^{Sup-of-Sup}_{f,T-2}$ to $Exposure^{Suppliers}_{f,T-2}$, and $Exposure^{Buy-of-Buy}_{f,T-2}$ to $Exposure^{Buyers}_{f,T-2}$. 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 A5: **Role of Financial Constraints: Alternative explanations**

Dependent Variable:	$(\ln Sales_{f,t=1} - \ln Sales_{f,t=0})$	
	(1)	(2)
$\Delta \ln \tau_f$	**-9.513*****	**-10.85*****
	(2.924)	(2.418)
$HighLev_{fsr,2010} * \Delta \ln \tau_f$	-3.070	
	(4.533)	
$Small_{fsr,2010} * \Delta \ln \tau_f$		2.998
		(5.760)
$\Delta \ln \tau_f^{Suppliers}$	**-9.447****	**-9.925****
	(4.259)	(4.149)
$\Delta \ln \tau_f^{Buyers}$	-1.560	-2.772
	(1.729)	(1.795)
$HighLev_{f,2010}$	0.0009	
	(0.003)	
$Small_{f,2010}$		0.0166***
		(0.00312)
R^2	0.0220	0.0199
N	69,293	69,293
Fixed effects	sr	sr

Notes: The dependent variable is the growth rate of sales of firm f operating in industry s and located in region r between 2011 and 2012. τ_f captures the firm-level effective tax rate, as defined in equation (5a). The indirect tax variables are defined in equations (5b), and (5c)). $HighLev$ is a dummy variable indicating whether the firm leverage was above the industry median as of $T-2$, and $Small$ is a dummy variable which takes on the value one if the firm size, measured in employment, was below the industry median as of $T-2$, and zero otherwise. 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 A6: **Role of financial constraints: Is it about liquidity or size?**

Dependent Variable:	$(\ln Sales_{f,t=1} - \ln Sales_{f,t=0})$
	(1)
$\Delta \ln \tau_f$	**-11.66*****
	(2.488)
$\Delta \ln \tau_f^{Suppliers,Small}$	**-15.55*****
	(3.620)
$\Delta \ln \tau_f^{Suppliers,Large}$	**-12.63*****
	(3.995)
$\Delta \ln \tau_f^{Buyers,Small}$	3.671
	(4.352)
$\Delta \ln \tau_f^{Buyers,Large}$	-3.378
	(3.796)
$\beta^{Suppliers,Small} = \beta^{Suppliers,Large}$	0.240
R^2	0.0194
N	69,293
Fixed effects	i-r

Notes: The dependent variable is the growth rate of sales of firm f operating in industry s and located in region r between 2011 and 2012. τ_f captures the firm-level effective tax rate, as defined in equation (5a). The indirect tax variables are defined in equations (5b), and (5c)). $\tau_f^{Suppliers,Large}$ ($\tau_f^{Buyers,Large}$) denotes the weighted average of large suppliers' (buyers') effective tax rate (i.e. suppliers (buyers) with firm-level employment above the industry median as of $T-2$) of firm f. $\tau_f^{Suppliers,Small}$ ($\tau_f^{Buyers,Small}$) denotes the weighted average of liquidity-constrained suppliers' (buyers') effective tax rate (i.e. suppliers (buyers) with firm-level employment below the industry median as of $T-2$) of firm f. 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: **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