Trade Shocks and U.S. Firms' Global Supply Chains

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Global supply chains are a pervasive feature of the modern production landscape and a potentially important channel of transmitting shocks across locations. Thus, quantifying the impacts of trade shocks requires understanding how firms adjust their global supply chains. Our proposal leverages detailed information about buyer-supplier relationships in U.S. import transactions to quantify how the margins of global sourcing respond to shocks (primarily tariffs and natural disaster risk). We build on and deploy our existing data infrastructure from Handley, Kamal and Monarch (2020), hereafter HKM, where we examine the impacts of the 2018-2019 U.S. import tariff increases on U.S. export growth through the lens of supply chain linkages.

In HKM, we map firm-level global supply chains into product-level measures of exposure to the 2018-2019 U.S. import tariff increases. We construct measures of exporters facing new import tariffs on their imports using detailed import and export transaction records. We link these measures with contemporaneous, public-use monthly trade flows to find that supply chain spillovers from the import tariffs dampened U.S. export growth over 2018-2019.

This research proposal, using newly available firm-transactions linked data, delves deeper into firm-level responses using country and product level import growth measures that parsimoniously summarize the intensive and extensive margins of sourcing. We focus primarily on the (plausibly) exogenous variation in import tariffs from the 2018-2019 U.S. tariff war against China and other countries. We use this policy shock to analyze heterogeneity in the response of U.S. firms' imports across countries, product characteristics and substitutability, and organizational structure.

Impact of 2018-2019 Import Tariffs on Buyer-Supplier Relationships

We will analyze the *firm-level* supply chain disruptions of the 2018-2019 U.S. import tariff increases using the Longitudinal Firm Trade Transactions Database or LFTTD (Kamal and Ouyang, 2020). The LFTTD contains the universe of merchandise import transactions valued at or over $2,000 and is available from 1992-2018. This proposal will employ a beta version of the 2019 LFTTD to estimate the response to tariffs.[1] The LFTTD uniquely identifies the U.S. firm and the foreign supplier in an import transaction. Foreign supplier information appears in the manufacturer identifier (MID) which is an alphanumeric code constructed using a combination of the name and address of the foreign manufacturer (Kamal and Monarch, 2018). Using the MID, we can measure a U.S. firm's imports (the buyer) at the country-product-supplier level.

Observing individual buyer-supplier relationships enables us to characterize foreign sourcing patterns and concentration along several dimensions: (1) the degree of exposure to foreign sourcing by products that support national critical functions as identified by Department of Homeland Security (DHS)[2]; (2) NAICS industries that use products highly concentrated in a small number

[1] The beta 2019 LFTTD is a product of our ongoing project.

[2] Referring to this document in the call for proposals here `https://www.cisa.gov/sites/default/files/publications/national-critical-functions-set-508.pdf`

source countries or foreign suppliers; and (3) share of employment and sales at firms that rely on these concentrated imports using the Longitudinal Business Database (LBD), available from 1992-2017, to obtain firm characteristics.

Framework

We present our framework for measuring the dynamics in U.S. buyer-foreign supplier relationships during the 2018-2019 trade war.

We measure imports M_{cpt} by source country (c), product (p), and time (t) and compute the growth rate as $g_{cpt} = \frac{M_{cpt} - M_{cp,t-1}}{\overline{M}_{cpt,t-1}}$, which is the difference in trade normalized by average trade $\overline{M}_{cpt,t-1} = (M_{cpt} + M_{cp,t-1})/2$ between two periods.[3] Using LFTTD, this trade growth measure can be decomposed into the contributions from the intensive margin (continuing relationships that are expanding or contracting) and the extensive margin (adding/dropping of suppliers within source countries or the entry and exit from foreign sourcing) as follows:

- Gross Trade Creation, TC_{cpt}, is the sum of (1) trade in continuing buyer(b)-supplier(s) relationships that are expanding, $TC^{cont}_{cpt} = \sum_{bs \in cont} \max\{M_{bscpt} - M_{bscp,t-1}, 0\}$, (2) trade from the addition of new buyer-supplier relationships in country c by continuing buyers (b) given by $ADD_{cpt} = \sum_{bs \in ADD} M_{bspt}$, and (3) trade from the entry of new buyers from any relationship in country c, $ENTRY_{cpt} = \sum_{bs \in ENTRY} M_{bspt}$.

- Gross Trade Destruction, TD_{cpt}, is the sum of (1) trade lost in continuing buyer(b)-supplier(s) relationships that are contracting, $TD^{cont}_{cpt} = \sum_{bs \in cont} \min\{M_{bscpt} - M_{bscp,t-1}, 0\}$, (2) trade lost from discontinuation of existing buyer-supplier relationships in country c by continuing buyers (b) given by $DROP_{cp,t-1} = \sum_{bs \in DROP} M_{bsp,t-1}$, and (3) trade lost from the exit of buyers from any relationship in country c, $EXIT_{cp,t-1} = \sum_{bs \in EXIT} M_{bsp,t-1}$.

We can now decompose total growth in imports as,

$$g_{cpt} = \frac{TC^{cont}_{cpt} - TD^{cont}_{cpt} + ADD_{cpt} - DROP_{cp,t-1} + ENTRY_{cpt} - EXIT_{cp,t-1}}{(M_{cpt} + M_{cp,t-1})/2}. \tag{1}$$

This growth decomposition illuminates the contribution of each margin to changes in U.S. imports that are masked in aggregated data. For example, trade growth in a particular country-product may be characterized by substantial churning in buyer-supplier relationships, which suggests firms can easily substitute across suppliers, even though changes in aggregate trade flows from year to year are stable and consistent. Alternatively, suppose imports from China decline in response to new tariffs. Our decomposition would reveal whether the decline was from a contraction of existing relationships, TD^{cont}, buyers dropping suppliers, a slow down in expansions, TC^{cont}, or the exit of buyers from the source country.

[3] This rate is symmetric, bounded on $[-2, 2]$, and accommodates zeroes. It is equivalent to log changes up to a 2nd-order Taylor approximation and has been used in dynamic trade analysis (e.g. Carballo et al. (2018)).

Analysis

Our first order approach to understand buyer-supplier relationships will focus on characterizing import growth across the margins in (1). We will initially evaluate correlations between growth margins and source country GDP growth and exchange rates. We can also compute transport costs (by air, sea, and land freight) at the country-product level directly from import transactions data and relate these to the growth margins. We intend to highlight industries (and products therein) from the DHS list of National Critical Functions. We also observe whether an import transaction occurs at arms-length (outside the boundaries of the firm) or between related parties (where either the buyer or supplier has an ownership stake in the other party). We can explore whether related party trade, where contracting and transactions costs may be lower, is different than arms-length trade across various margins.

We will then turn to estimating the effect on supply chain relationships of new U.S. tariffs, which we view primarily as a demand shock for U.S. buyers. Our initial identification strategy is to use country and time variation from the 2018-2019 U.S. trade war against China and other major trade partners to estimate the effects on buyer-supplier import growth margins. It is now well known that the trade war had a negative impact on import volumes (cf. Amiti et al., 2019). But we mainly have anecdotal evidence on whether import reductions occurred on the intensive margin of existing trade relationships or the extensive margin. This distinction is important because forming buyer-supplier relationships in a supply chain can require sunk bilateral investments. Buyers and suppliers may be reluctant to form new supply chain relationships following a shock (e.g. a tariff) or when the risk of future negative shocks is high. Likewise, once the relationships are broken, imports may not recover quickly, if it all, whereas continuing relationships that only contract in volume may return to normal in the post-shock period.

Using existing data infrastructure from HKM, we will compare the margins of growth in country-product varieties that face tariffs in 2018-2019 to those that never face tariffs. A straightforward approach will use binary indicators for newly tariffed products, which we will later extend to continuous tariff changes. Our representative regression takes the following form,

$$g_{cpt} = \gamma \boldsymbol{I_{pct}}(\Delta \text{Tariff}_{pct} > 0) + \boldsymbol{X_{pct}\beta} + \alpha_{ct} + \alpha_{it} + \alpha_{cp} + \varepsilon_{cpt}, \tag{2}$$

which includes fixed effects for country-time (α_{ct}), industry-time (α_{it}) and a country-product panel ID, α_{pc}; and controls, $\boldsymbol{X}$, for transport costs and foreign tariff retaliation in related products.

We will run a set of regressions on each margin to obtain estimates of an overall effect, γ, and estimates of the contribution from the linear decomposition of each margin. There are several sources of heterogeneity we plan to investigate further.

Product characteristics and organization structure: Both the types of products and the nature of the transactions could impact supply chain responses to shocks. We will characterize imported products as final or intermediate goods. One approach will use the U.N. Broad Economic Classification of goods into these groups. A second plant-level approach will use the detailed input-

output usage from the Census of Manufactures (CMF) and the Annual Survey of Manufactures (ASM) following Boehm et al. (2019).[4] This will allow us to run separate regressions by product characteristics to estimate the effect of tariffs.

We also observe firm organizational structure in the data, i.e. related party vs. arms-length relationships. Integrated relationships may be more robust to shocks, but arms-length relationships may allow greater flexibility. We can break out tariff shock effects by buyer-supplier affiliation and growth margins to explore these dynamics.

Heterogeneity relative to elasticities of substitution (EOS): We will estimate the EOS across foreign suppliers for a given product as an alternative measure of supply chain risk and responsiveness. Supplier switching should be more prevalent in high relative to low EOS goods generally and in response to shocks. We will build on Hottman and Monarch (2020) to estimate elasticities using a CES variety-level demand function governed by sector-level EOS across various foreign suppliers.[5] We understand that standard estimation methods have limitations for global supply chain analysis because they require that the underlying variety measure (e.g. country-product, country-product-buyer, etc.) is continuously traded between time periods and assume CES functional forms. Supplier substitution may depend on the number of potential suppliers and firm or country characteristics and estimates can vary over time periods and be fairly noisy.[6] We will bin the elasticities into high, medium and low terciles as coarse rankings are less likely to suffer from measurement error. We can then compare these EOS groupings to extensive margin churning in import growth and estimate whether higher or lower EOS products respond differently across margins during the 2018-2019 trade war.

Cross-country switching dynamics: Since we observe the U.S. firm in an import transaction, we can quantify the contributions to import growth in country(c)-product(p) from firms that are expanding (or contracting) in imports of the same product from another country c'. For instance, we can determine if U.S. importers switched to other source countries after increases in tariffs on Chinese goods.

Aggregation and trade diversion: The growth measure in eq. (1) allows simple aggregation up to the product, country, or broader industry level. For example, aggregate import growth in product p can be obtained by taking the weighted average over all source countries for p where the denominator in (1) is the weight. Growth in product p can be decomposed into imports from China (Ch) and the rest of the world (W), e.g. $g_{pt} = \frac{\overline{M}_{pt}^{Ch} \times g_{Ch,pt} + \overline{M}_{pt}^{W} \times g_{W,pt}}{(M_{pt} + M_{p,t-1})/2}$. Used as a dependent variable with an indicator for tariffed products, we can estimate which products adjust within and across

[4]The CMF and ASM collect information on products produced and used as inputs at manufacturing plants from 1992-2017. This analysis will focus only on firms that operate in the manufacturing sector.

[5]We will estimate these elasticities via GMM, using prices and market shares for each foreign supplier that are differenced over time and across suppliers within a time period.

[6]Seminal papers on this topic, e.g. Broda and Weinstein (2006), focus on computing CES price indices and welfare. The noise is less problematic in this context and entry and exit of varieties is handled independently from the estimation methods.

countries. Thus, we can capture changes in the composition of import growth induced by trade diversion away from tariffed countries and relative to sources of heterogeneity described above. Alternatively, we can estimate weighted OLS regressions to estimate the aggregate effect across margins but maintaining the rich set of controls available with country by product variation.

Timing: The period of time for supply chains to adjust to tariff shocks is an empirical question. Moreover, the tariff increases we study are implemented in multiple waves as described in HKM. We will compute growth rates over different intervals to evaluate the impact of the time frequency on measures of supply chain resiliency. This will include growth over longer horizons relative to a base year of 2017 and over smaller time windows, e.g. year-on-year quarterly growth.

Non-tariff supply chain shocks: We will study how other global and regional supply chain shocks beyond tariffs may affect the margins of U.S. imports. Several catastrophic events in the past 15 years provide exogenous variation within and across specific countries: (1) the 2004 Boxing Day Tsunami in Indonesia, Thailand, Sri Lanka and India; (2) the 2011 Tohuku earthquake and tsunami in Japan; and (3) the 2011 severe flooding of coastal areas of Thailand. Our main innovation here is to identify U.S. firms' imports from different cities within a source country. The city and regional information is embedded in the foreign supplier identifier (MID) described above. Thus, we can construct product-level exposure measures of U.S. imports within and across countries following HKM. We can decompose growth margins in the aftermath of these shocks to better understand supply chain risk and sensitivity. More broadly, our findings should be informative about short to long run effects of supply chain disruptions from the COVID-19 pandemic.

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