Trade Policy and Exporters' Resilience: Evidence from Indonesia*

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Abstract

How does trade policy affect exporters' ability to respond to foreign demand shocks? Faced with a sudden change in the demand for their goods, exporting firms must optimally change their inputs and/or input sources. This paper tests whether a country's trade policy makes such adjustments harder for firms relying on imported inputs. The analysis exploits new time-varying data on non-tariff measures (NTMs) faced by Indonesian firms and focuses on the impact of exchange rate shocks on exports to Japan, a key market for both Indonesian and Chinese firms. In response to a depreciation of the yuan which makes Chinese exports more competitive in Japan, firms facing NTMs on their inputs see a much larger drop in their export values compared to firms that do not face any NTMs. The magnitude of this effect depends on the type of NTM and on firms' characteristics, such as their size and product quality.

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1 Introduction

The COVID-19 crisis has renewed the interest of economists in the determinants of firms' ability to adjust to economic shocks. A relatively large literature has analyzed different types of firm-level characteristics such as innovation activities, management practices, and market power that determine the extent of adjustment to such shocks (Gupta, 2020; Hyun et al., 2020; Ding et al., 2021). Despite yielding important findings on firms' resilience to shocks, these studies may provide limited guidance to policy-makers as many factors that are not directly affected by policies can explain the variations in these characteristics across firms.

In this respect, the role of trade policy is a particularly important gap in the literature, given the increasing connectedness of firms through global value chains. Access to foreign intermediate inputs can increase the amount and quality of firm-level exports by exposing firms to new inputs and technologies (Goldberg et al., 2010; Fan et al., 2015; Halpern et al., 2015; Feng et al., 2016). As a result, a firm that is an exporter is also more likely to be an importer. Faced with a sudden change in demand for their goods, exporters need to optimally change their inputs and/ or input sources. To the extent that import measures change the relative costs of such adjustments, they could have a prominent impact on the resilience of firms to shocks.

This paper helps to fill this gap by examining the role of trade policy, in particular, non-tariff measures (NTMs), in affecting the resilience of exporters to a demand shock. To do so, we match novel data on Indonesia's trade policy measures at a highly disaggregated product level with data on the universe of Indonesian exporters.

While data on import tariffs are relatively more available, a key innovation of this paper is the extensive coverage of NTMs, which represent increasingly important but still under-researched trade policy instruments (Nicita, 2012). Specifically, we address the data limitation by assembling a novel hand-collected database of NTMs from different regulatory agencies in Indonesia for 2014-2018. We then link these NTMs (as well as tariffs) to firm-level customs data at the 10-digit HS level, the most detailed product classification available. Using these data and highly disaggregated information on import tariffs for the same period, we analyze how different trade policy interventions affect the ability of Indonesian exporters to adjust to sudden changes in foreign demand. Specifically, we focus on how exchange rate shocks in the Chinese yuan affect Indonesian firms' exports to Japan, the largest regional trading partner for Indonesia (after China) and the export destination for 8,353 Indonesian firms.[1]

[1]The largest regional trading partner is China. Since we use variations in demand arising from exchange rate shocks in yuan/USD we do not study China as the destination market but as a competitor in the Japanese market.

Indonesia provides a suitable context for the analysis for several reasons. First, it fits remarkably well the general pattern of trade policy in developing countries over the past three decades, namely, import tariff liberalization since the 1990s and a contemporaneous increase in NTMs. Second, many of these NTMs are applied on intermediate inputs and have been changed frequently over time, thus providing a rich source of variation for our analysis. Specifically, merging customs and policy information allows us to build a unique dataset on the universe of exporters and their imported inputs with precise time-varying data on trade policy at a detailed product level. Finally, many Indonesian exporters compete with Chinese producers in third markets, particularly Japan. Importantly for our analysis, Indonesian exports are denominated in USD. These characteristics allow us to exploit the significant changes in the USD/yuan exchange rate in the 2010s as an exogenous demand shock to Indonesian exporters to Japan.

The demand shocks we use are monthly variations in exchange rates between the yuan and the USD. Such exchange rate movements—out of the control of Indonesian firms—affect their exports by changing the relative prices of Indonesian and Chinese goods in Japan, where the largest share of imports are from China. Consider a depreciation of the yuan versus the USD, which is the case for most of our sample period. One of the key strategies through which an Indonesian exporter could counter the increase in Chinese competition associated with this exchange rate shock is to lower its marginal costs. When labor costs are relatively sticky in the short term, this can be achieved mainly by adjusting the intermediate input mix. As exporters are especially dependent on imported inputs, import measures can affect their ability to switch inputs and – hence – to respond to the shock. By increasing the uncertainty and/or the fixed cost per shipment of new import varieties, NTMs would typically raise the cost of switching intermediate inputs. That is not the case for import tariffs, which raise the cost of the imported inputs proportionately to their value but do not normally increase the uncertainty on the timing of input availability.

To test these hypotheses, we employ a differences-in-differences approach. Specifically, we study how firms facing different levels of NTMs and import tariffs on their inputs and different levels of exposure to Chinese competition in the Japanese market respond to exchange rate shocks in the yuan. This approach builds on the theoretical framework of Feenstra et al. (2018) and Mattoo et al. (2017), who analyze how depreciation in the yuan affects exports from third-country markets. Differently from these papers, we analyze the export response of Indonesia at the firm level and focus on how trade restrictions on inputs affect this response. Intuitively, this strategy captures the differences in the elasticity of exports to exchange rate shocks between two firms that face exactly the same level of Chinese competition but different levels of NTMs and tariffs.

Our estimates of the effects of NTM exposure of imports on firms' exporting behavior could be biased if the same time-varying unobservables affect trade policy measures and export responses. For example, a common concern in the trade protection literature is that certain firms or industries can lobby with the government and influence trade policy in their favor. We address the potential endogeneity of trade measures in various ways. First, our model employs an extensive set of firm-product, product-time, and firm-time fixed effects that control for any time-varying shocks at the firm or product level that may drive both export outcomes and our identifying variables. Similarly, such controls also address possible reverse causality issues, including firm- or sector-level lobbying efforts. Second, as further robustness checks, we add baseline export-product characteristics interacted with time effects and exclude the dominant exporters in specific products. Third, we construct the trade exposure measures using time invariant weights based on the firms' import shares at baseline. Using the baseline import shares addresses the concern that if firms substituted away from imports subject to NTMs for imports that were not, we would be underestimating the firms' exposure to NTMs.

We find that NTMs negatively affect firms' resilience. In response to depreciations of the yuan, we find that firms that face NTMs on their inputs see a much larger drop in their export values compared to firms that do not face any NTM. If we compare two firms facing the same (mean) level of Chinese competition, the firm at the $75th$ percentile of NTM exposure will see a 2% larger fall in exports than the firm at the $25th$ percentile of NTM exposure. On the other hand, we find no significant effect of tariffs on exports.

We then explore how different NTMs affect exports without bundling all the NTMs into a single measure. A key distinction here is between NTMs that address possible negative externalities of trade, such as measures protecting consumers' health by establishing permissible maximum residues of harmful substances in food and those which do not. As we do not observe the value of such externalities, our estimates cannot speak to the net economic effects of all NTMs. Hence, we study the impact on exporters' resilience to shocks of the most prevalent NTMs that do not address a negative externality. In particular, we identify four such measures and estimate their effects individually. The results suggest negative and significant impacts of each of these NTMs on exporters' responses, thus identifying possible opportunities for welfare-enhancing reforms.

We then investigate the mechanisms through which NTMs affect firms' resilience to demand shocks. We find that firms that import inputs less frequently, are smaller in size, and produce high-quality goods suffer more from the presence of NTMs following a yuan depreciation. These findings are consistent with the intuition that NTMs make it harder to adjust inputs for less flexible firms. Note that a possible confounding factor is that a

depreciation of the yuan increases the competitiveness of Indonesian firms relying on Chines inputs. In an extension, we use a more conservative specification in which we control for a firm-time level measure of exposure to Chinese input share for Indonesian firms. All NTMs continue to have a negative impact on exports of firms more exposed to NTMs.

This paper relates to three strands of recent literature. The first is the literature on the economic effects of trade policy (Goldberg and Pavcnik, 2016; De Loecker et al., 2016; Amiti and Konings, 2007; Handley et al., 2020; Fan et al., 2015; Amiti et al., 2019; Handley et al., 2020b; Fajgelbaum et al., 2020) and non-tariff measures in particular (Ederington and Ruta, 2016; Fontagné et al., 2015; Grundke and Moser, 2019; Kruse et al., 2021). A key message from this literature is that, as NTMs have progressively replaced tariffs as a determinant of trade costs, an analysis focused on these measures is needed to precisely assess the impact of trade policy. In turn, this requires having more detailed information on the exact type and content of NTMs. This paper is the first to compute a firm-level NTM exposure measure by utilizing the information on NTMs imposed on the imports of an exporter at the firm level, which allows to establish a causal relation between NTMs and firm response to shocks. Similarly to work on tariffs and firms' performance (e.g. Amiti and Konings (2007)), we find that NTMs on imported inputs can reduce the ability of firms to adjust to shocks.

A second related literature is the body of work that studies the determinants of firms' resilience to shocks, particularly through global value chains. Recent papers exploit natural disasters such as the Tōhoku earthquake off the coasts of Japan in 2011 to analyze how shocks transmit through firms' operations either domestically (Carvalho et al., 2016) or internationally (Boehm et al., 2019). A second group of studies focuses on the impact of the COVID-19 shock, and the related lockdown measures, on firms participating in GVCs (Espitia Rueda et al., 2022; Berthou and Stumpner, 2022; Lafrogne-Joussier et al., 2021)). Finally, another group of recent studies investigates how firms re-organize production in response to different types of economic and policy shocks (Navaretti et al., 2019; Caliendo et al., 2020). Our paper contributes to this literature by providing novel evidence on the role of policy factors, particularly the stringency of NTMs and tariffs, mediating the impact of economic shocks.

Finally, our paper relates to the voluminous literature on exchange rate shocks and trade (e.g., Berman et al. (2012); Amiti et al. (2014)). The large majority of this work focuses on the impact on a country's exports when its currency becomes more volatile or changes in level (either appreciates or depreciates). As discussed above, our approach is similar to Mattoo et al. (2017) which studies the impact of a change in the yuan on third countries' trade. We contribute to this literature by documenting the sensitivity of exports to the exchange rate shock of a competitor country but at the firm level and showing how

this sensitivity is affected by the countries' own trade policy.

The rest of the paper is organized as follows. Section 2 describes how trade policy affects firms' resilience to export demand shocks. In section 3 we discuss the empirical context of the paper, including the exchange rate shocks and the Japanese export market, and our data sources. In section 4, we present our main empirical strategy and identifying assumptions. In section 5 we illustrate the results, including evidence for the main mechanism underlying our findings and different robustness checks. Lastly, section 6 concludes with a discussion of the policy relevance of our findings.

2 How import measures can affect firms' resilience

This section seeks to clarify how NTMs on imports could affect a firm's response to an export demand shock. To that end, it is important to distinguish between import tariffs and NTMs. Consider an exporting firm importing inputs needed in its production process. Import tariffs entail an increase in the cost of imports proportionate to the imported value. NTMs entail an increase in the cost of importing which is usually not related to the value of imports and may vary depending on the nature of the compliance implied by the measure. For instance, a pre-shipment inspection (PSI)–one of the most widespread NTMs during our analysis–involves a third party verifying that the containers' products are correctly identified in the import declaration. This verification generates a monetary cost per shipment as well as increased uncertainty in terms of the time it takes for the firm to receive the imported inputs.[2] More broadly, NTMs generate various compliance costs, increasing the uncertainty around import timing and, hence, costs. That is for two reasons. First, authorities have discretion in verifying compliance with each measure which can give rise to uncertainty on the timing of clearance.[3] Second, the variability in demand for compliance verification (dependent on importing patterns) can generate delays in clearance times.

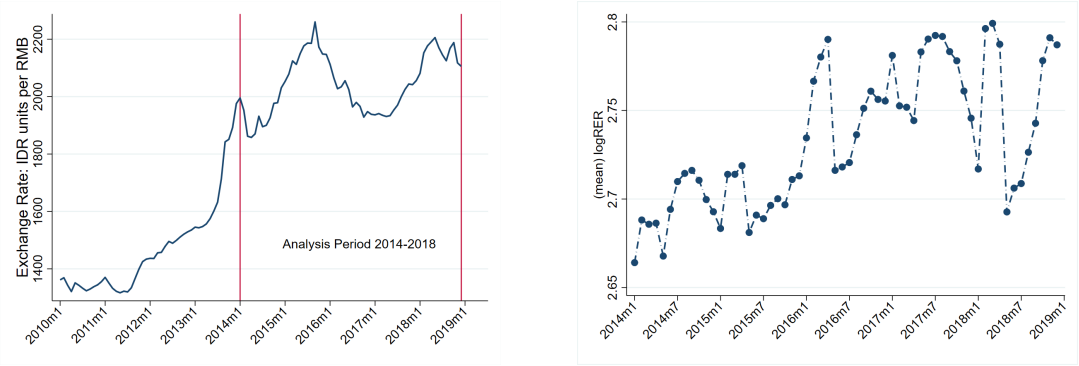
How do import tariffs and NTMs affect firms' responses to export demand shocks? To fix ideas, let us assume a depreciation of the yuan versus the USD, which is the case for most of our sample period (Figure 1). For Indonesian exporters to Japan, which invoice in USD, this exchange rate movement represents a negative demand shock in the export market, particularly for goods with stronger Chinese competition. We are interested in how import measures on firms' intermediate inputs affect the heterogeneity of responses to this shock across Indonesian exporters. Once hit by the exchange rate shock, the exporter could

[2]Consistent with the hypothesis of increased uncertainty, Calì et al. (2021) show that PSI significantly reduces the number of imported shipments and increases the average value per shipment.

[3]Chalendard et al. (2020) show that collusion between custom inspectors and importers significantly reduces custom clearance times in Madagascar.

counter the associated increase in competition by lowering its marginal costs and/or mark-up. The extent to which the Indonesian exporter can alter its mark-up depends on several factors, such as the degree of market power of the firm, but not directly on the intermediate input choice.

Figure 1: RMB units per USD



a. IRD Units to RMB b. Log RER RMB units to USD

Source: Author Calculations

The firm can lower its marginal costs by adjusting its variable costs, particularly those associated with intermediate inputs.[4] That is the case as the other variable cost–labor–is typically sticky in the short-term, especially if firing costs are high (Adhvaryu et al., 2013), as in the case of Indonesia.[5] Reducing input costs typically involves switching to cheaper intermediate inputs from the same supplier or a different one. As exporters are especially dependent on imported inputs, including in Indonesia (Rahardja and Varela, 2015), then import measures can affect the exporter's ability to switch inputs and, hence, to respond to the shock.

Consider first the case of NTMs. As NTMs increase uncertainty and/or the fixed cost per shipment of new import variety (as discussed above), they raise the cost of switching intermediate inputs. This is consistent with existing evidence of the impact of trade policy uncertainty on inputs' adoption (Handley et al., 2020a; Imbruno, 2019). Conversely, import tariffs raise the cost of the imported inputs proportionately to their value, but they do not increase the uncertainty on the timing of input availability. As a result, tariffs should not

[4]Lowering the marginal costs may entail switching to a lower quality segment or sourcing from a new supplier.

[5]According to World Bank Doing Business data, during the period of analysis, Indonesia had the most onerous employment termination rules among middle-income and Southeast Asian countries. Indonesian employers had the obligation to both notify the workers' representatives in case of dismissal and to seek approval for the worker's dismissal by the judicial bodies in case no agreement with the worker can be found. In addition, the severance payment accruing to the worker upon dismissal was particularly generous in Indonesia. For example, a worker with 10 years of tenure was entitled to 95 salary weeks for redundancy dismissal versus 50 in Thailand, 43 in Vietnam and the Philippines, 33 in Malaysia, and 21 in India.

affect the cost of input switching for the exporter. This is consistent with the evidence for Indonesia, that import tariffs–unlike PSI–do not affect the number of import shipments of the firm (Calì et al., 2021). Appendix A2.2 also provides empirical evidence in support of this hypothesis, showing that an increase in NTMs faced by the firm reduces the number of imported varieties (as measured by the total number of unique HS-8 and source country pairs). We do not find any such effect for tariffs, across the different types of specifications in Table A3.

The same type of arguments would apply–mutatis mutandis–also in case of an appreciation of the yuan-USD exchange rate. In this case, the exporter would be faced with reduced competition and would need to source additional intermediate inputs to take advantage of the new market opportunities. Again, the uncertainty induced by NTMs would increase the costs of the additional sourcing for exporters.[6]

This discussion allows us to formulate two testable hypotheses for our empirical analysis: (i) NTMs reduce the ability of exporters to cope with the exchange rate shock, hence magnifying the negative export impact of yuan depreciation and reducing the positive impact of an appreciation; and (ii) import tariffs should not affect the response of the exporter to the same shock.

3 Data and Context

To carry out the analysis, we make use of two main novel sources of data. The first is monthly data on the universe of Indonesian exporters and importers which was confidentially shared by the Indonesian Directorate General of Customs and Excise (DGCE, referred to as DG Customs in the paper) within the Ministry of Finance.[7] The second is a time-varying data of NTMs at a highly disaggregated level of sectoral classification (HS-10 digit), which was assembled and maintained for Indonesia by the World Bank. This data was compiled based on extensive regulatory checks and varies monthly at 3-digit MAST classification and 10 digit HS level. This section also provides information on other data used in the analysis and the choice to focus the analysis on Indonesian firms' exports to Japan.

[6] In the case of a homothetic production function, where inputs increase proportionally, uncertainty would make the sourcing of additional inputs more costly, but the firm would not need to switch inputs to expand production. In the case of a non-homothetic production function, exporters would be affected both by uncertainty and the cost of switching inputs.

[7] This was the result of an ongoing collaboration with the World Bank office in Jakarta.

3.1 Indonesian customs data

For the trade data, we use customs-level data covering the universe of Indonesian exporters from 2014 to 2018 in a monthly series. The Indonesian customs collect the data and record values exported and imported by each firm at the 10-digit Harmonized System (HS) level. The data also has information on the country of destination, the value of exports, the quantities, and status of the exporting firm (for example, whether it is a producer and/or a general importing firm).

The data covers the universe of all Indonesian exports in the period, except those from export processing zones. Thus our data accounts for more than 90% of overall exports. The data contains 69,383 firms, of which 37,260 are importers and 44,363 are exporters. One of the appealing features of the data is the connection between importing and exporting activities at a highly disaggregated level (10-digit HS code). The data contains the monthly dollar value and quantities of imports and exports at the firm-month-HS-10 product level, along with information on the country of origin for imports and the destination for exports, whether the importer is a producer or a pure trader, and the customs' treatment (e.g., privilege customs status). Since we are interested in how NTMs applied on imports affect exports when there is a demand shock, we only use data on the population of Indonesian exporters which also import directly.

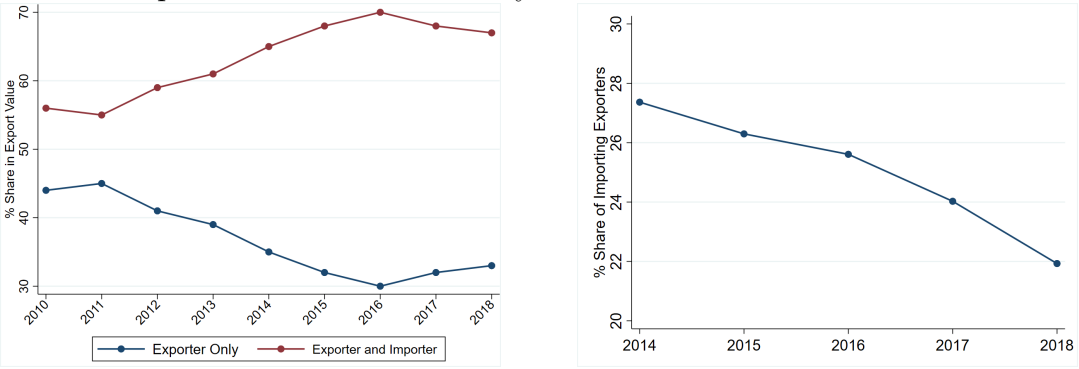
A total of 12,735 firms, representing about 18% of all exporters, both import and export directly during 2014-2018. Despite being fewer than a fifth of exporters, these firms account for over two-thirds of Indonesian export value (figure 2). The other 37% of exports came from firms that do not import directly but may purchase imported inputs through third parties. This is consistent with stylized facts globally where importing exporters tend to dominate trade (World Bank, 2020). Though dominant in the export market, the share of importer exporters has been declining over the recent years, as evident in figure 2 b. During the same time, the share of exporters who face at least one NTM has been increasing, as discussed in section 3.2 below.

3.2 Indonesian NTM and tariff data

NTM-related regulations have been spread out among a total of 13 government institutions (ministries, agencies, and some are issued as a presidential decree) during our period of analysis (2014-2018). Each institution has its own mandate. This makes monitoring NTMs difficult since no dedicated government institution can carry out NTM regulatory review and stocktaking (Munadi, 2019).

To overcome these issues, we use a novel comprehensive NTM data-base built by the

Figure 2: The Export Value is Dominated by GVC Firms but their share has been Declining



a.Export Value Share b. Importing exporters

Source: Author Calculations

World Bank based on data collected by the Economic Research Institute for ASEAN and East Asia (ERIA) in collaboration with UNCTAD (Calì et al., 2021). The UNCTAD/ERIA data identifies the stock of NTMs applied by Indonesia as of 2015. The data is cleaned extensively to address coding and interpretation errors and made time-varying by tracking the individual NTMs applied to each product before and after 2015.[8] The data uses the most disaggregated NTM classification available, i.e., 3-digit MAST level. This classification is the most appropriate for policy analysis as it identifies individual measures introduced or modified by each agency. A total of over 60 3-digit NTMs are available in the dataset, each with values coded between 0 and 1 to signify when they were in effect; that is, the data varies at the month-product pair.

In addition, we complete the trade policy data with import tariff data collected by the UNCTAD Trade Analysis Information System (TRAINS) data-set. For Indonesia, this data includes yearly Most Favored Nations (MFN) applied import tariff at the HS 10-digit product level before 2017 and HS 8-digit level from 2017 onwards./footnoteThe MFN typically provides an upper bound of the applied tariff as it does not include preferential tariff regimes. However, the MFN is the most appropriate tariff data in our paper which does not distinguish between import sources. We then convert all of the tariff data into the 10-digit used for the NTMs as well.

[8]ERIA has updated the data and the latest one is 2018, where some of these coding errors may have been addressed. Calì and Montfaucon (2021) details the process, dissimilarities, and coding errors corrected by the data. Additionally, Calì et al. (2021) also provide more details on the construction of the data and the institutional context.

3.3 Japan: The main regional destination for Indonesian and Chinese exports

We base the analysis on a single individual export market to make the empirical analysis manageable and to focus on a similar set of exporters facing the same shock. Several reasons make the Japanese market particularly suitable for this analysis.

First, Japan is the most important regional trading partner for Indonesia (excluding China) and is among Indonesia's top three export destinations in our sample period. Exports to Japan represent about 10% of all export value for Indonesia.

More importantly, Indonesian firms face a high degree of competition from Chinese firms in Japan as China is Japan's top trading partner in terms of imports, with over 20% of Japanese imports originating from China in 2018.[9] Indeed, Japan is also among the top 3 export destinations for China. A total of 8,353 Indonesian firms exported to Japan between 2014-18 and, among these firms, a total of 5,425 imported and exported.

A further reason to focus on Japan is the high quality of the data. We are able to obtain information on total Japanese imports and imports from China into Japan at the monthly frequency at the HS-9 digit product level from the Ministry of Finance in Japan. As our empirical analysis uses demand shocks faced by Indonesian exporters in Japan that are driven by fluctuations in exchange rates of yuan per USD, in section 3.4 below, we show the extent of exchange rate fluctuations during our period of analysis.

Finally, it is worth noting that Indonesia and Japan have an economic partnership agreement regulating their trade. However, this should not affect our analysis as the agreement was signed in 2008, and its rules have not changed since, while our analysis covers a later period.

3.4 Exchange rates

We use data from the International Monetary Fund (IMF) International Finance Statistics (IFS) for our exchange rate data. The data is the monthly average of bilateral exchange rates between yuan and the USD. We also use IFS as a source for the Consumer Price Index (CPI) for the real exchange rate calculation. Figure 1 panel b plots the log value of real exchange rate between yuan and USD over the period of analysis, 2014-2018. While there have been significant short-term fluctuations in the yuan/ USD exchange rate during this time period, which we will exploit in our analysis, the overall trend has been toward depreciation.

In all our specifications, we use the log real exchange rate between yuan and USD for our analysis as the relevant exchange rate facing Indonesian exporters, since an average

[9] World Integrated Trade Solution (WITS)

of 94% of Indonesian exports (table A1) and 81% of imports were invoiced in the USD in our sample period. As pointed out by Gopinath et al. (2020), there is very little evidence that the best description of pricing in international markets follows either PCP (Producer Currency Pricing) or LCP (Local Currency Pricing). Instead, the vast majority of trade is invoiced in a small number of dominant, vehicle currencies (VCP), with the U.S. dollar playing an outsized role. It is, therefore the share of these small number of currencies that overwhelmingly determines the level of exchange rate pass-through, even under various exchange rate regimes (Montfaucon et al., 2021). Higher pricing in the USD leads to higher pass-through of the USD and higher sensitivity to trade when there are fluctuations (Boz et al., 2022), with pass-through often higher when a vehicle currency is used (Devereux et al., 2017). The bilateral exchange rate is thus not suitable for determining the pass-through of the exchange rate. Therefore, the yuan-USD exchange rate is more appropriate for this analysis.

4 Empirical Specification

In our main empirical specification, we analyze how firms facing different levels of NTMs on their inputs and different levels of exposure to Chinese competition respond to exchange rate shocks in yuan. Our empirical analysis builds on the theoretical framework of Feenstra et al. (2018) and Mattoo et al. (2017) who analyze how depreciations in yuan affect exports from third country markets. The major difference is that we analyze this export response at the firm-level, and focus on how NTMs and tariffs on inputs affect this response. Equation 1 below is our main empirical specification.

$$ln(V_{igt}) = \alpha_1 I_{ig,0} * ln(E^{China}_{USD,t}) + \alpha_2 I_{ig,0} * ln(E^{China}_{USD,t}) * NTMExposure_{i0,t} + \alpha_3 I_{ig,0} * ln(E^{China}_{USD,t}) * TariffExposure_{i0,t} + v_{ig} + S_{it} + \gamma_{gt} + \epsilon_{igt} \quad (1)$$

V_{igt} : The value of exports of HS-4 digit product g from firm i in Indonesia to Japan in month t; $I_{ig,0}$: The index of competition between Chinese exports and those of Indonesia in product g for Indonesian firm i in Japan in the initial time period (2014); $E^{China}_{USD,t}$: Exchange rate between Chinese yuan and USD, expressed as yuan/USD; $NTMExposure_{i0,t}$: The measure of NTM exposure of the firm i selling product g in month t, computed on the basis of the firm's initial composition of the import bundle. We will describe the construction of the Chinese competition index and the NTM exposure variable in detail below.

Following Mattoo et al. (2017), we formally define the competition index that each firm faces vis-a-vis China in equation 2 below.

$$I_{ig,0} = \sum_{g'=1}^{G} \left(\frac{EX_{ig',0}}{EX_{ig,0}} * MS_{g',0}^{China} \right) \tag{2}$$

$\frac{EX_{ig',0}}{EX_{ig,0}}$: Measures the importance of HS-6 product g' in the total exports of the HS-4 product g exported to Japan by the Indonesian firm i in the initial time period (time 0, which corresponds to 2014 in our analysis); $MS_{g',0}^{China}$: China's share of HS-6 product g' in the total imports of g' by Japan in 2014. The share of each HS-6 in an HS-4 product ($\frac{EX_{ig',0}}{EX_{ig,0}}$) is weighted by China's share of product g' in the total imports of g' by the destination country ($MS_{g',0}^{China}$) and summed over all HS-6 products g' within an HS-4 product g to arrive at a measure of Chinese competition index at the Indonesian firm i and HS-4 product g level. We follow Mattoo et al. (2017) in constructing this index at the HS-4 level using dis-aggregated product data at HS-6 to reflect the fact that too narrowly defined products, such as HS-8, may not accurately reflect the effects of Chinese competition while too broadly defined categories such as HS-2 may confound these effects.

Intuitively, according to this measure, if the HS four-digit product, let's say TVs, consists of only two items, color TVs and non-color TVs, the measure is simply the share of Chinese imports in Japan's imports of each type of TV, weighted by the importance of each type of TV in firm i's TV exports to Japan. If the firm faces no competition from Chinese imports, the value of this measure is 0, while if all the products face competition from Chinese imports and China's import share in all these products is close to 1, this measure is close to 1 as well.

S_{it}, v_{ig}, and γ_{gt} capture any firm-time, firm-product, and product-time characteristics, respectively. It is important to control for each of these fixed effects. Since we follow a panel of firms, firm-time fixed effects capture any time-varying unobservables at the firm level, for example, unobservable changes in firm productivity. Firm-product fixed effects control for any unobserved HS-4 product characteristics that vary across firms; for example, some firms could be supplying a higher quality HS-4 product than other firms. Product-time fixed effects control for any unobserved changes over time in product demand or product quality. As we argue below, these controls also help relieve concerns about the endogeneity of the trade measures.

4.1 Trade measures

Equation 1 includes two trade policy variables, which enable the identification of their effects on exporters' resilience to shocks. The first such variable - $NTMExposure_{i0,t}$ - measures the exposure to NTMs for firm i in month t. It does so by combining the initial weights

of different HS-10 products in a firm's import basket with product-level changes in NTM exposure over time at the HS-10 level. Using the baseline import shares addresses the concern that if firms substituted away from imports subject to NTMs for imports that were not, we would be underestimating the firms' actual exposure to NTMs. We combine the trade data with monthly data on NTMs applied by Indonesia on imports at HS-10 digit level to compute the share in value of HS-10 products that are subject to a specific NTM as a share of total imports in the first year of trading. More formally the exposure measure is as follows:

$$\text{NTM Exposure}_{i0,t} = \sum_j \left(\frac{IMP_{ij}}{\sum_j IMP_{ij}} \right) * NTM_{jt} \tag{3}$$

where j is the HS product, $NTM_{jt} = 1$ if an NTM on HS-10 product j was in effect in month t and 0 otherwise. $IMP_{ij} = \sum_{t=m1}^{t=m12} Imports_{ijt}$ and is the invariant weight of product j in exporter i imports. m_1 is the first month of the year that firm i joined the export market and m_{12} is the last month of that year. By definition, this weight will only have values for exporting firms that also import directly. For the aggregate NTM measure in Section 5.1, the NTM dummy (NTM_{jt}) is 1 if any of the 60+ NTMs in our data was in effect. For the specific, trade-distorting NTMs discussed in Section 5.2, $NTM_{jt} = 1$ if that specific measure was in effect.

The second trade measure $TariffExposure_{i0,t}$ is similar to the $NTMExposure_{i0,t}$. It is the measure of tariff exposure of the firm i selling product g in month t, where the weights of different HS-10 goods in the firm's import bundle are determined in the initial time period. We combine the trade data with monthly data on tariffs applied by Indonesia on imports. The exposure is computed as follows:

$$\text{Tariff Exposure}_{i0,t} = \sum_j \left(\frac{IMP_{ij}}{\sum_j IMP_{ij}} \right) * Tariff_{jt} \tag{4}$$

j is the HS product, $Tariff_{jt}$ is the tariff rate on HS-10 product j in month t, and all other variables are as previously defined in equation 3.

Table 1 shows the average degree of exposure to Chinese competition and the levels of NTMs that Indonesian firms faced during the analysis period. The average level of exposure to Chinese competition was about 0.27, with a high degree of variation. While firms at the bottom 10% of this distribution faced no competition from China, the top 10% faced an index above 0.89. The median firm faced an average NTM exposure of about 38% and average tariff exposure of only about 5%. There is also a larger dispersion in the extent of NTM exposures faced by firms compared to tariff exposure: While firms in the bottom

and top 25% of NTM exposures faced average exposures of 10% and 82%, the corresponding numbers for tariff exposures are only 2% and 12%. Table 1 also shows the average level and dispersion in specific types of NTMs faced by Indonesian firms, which we will discuss in section 5.2.

Table 1: Summary Statistics

	N	mean	sd	min	max
Competition Index	854318	0.27	0.31	0.00	1.00
Exposure to NTM	854318	.37	0.35	0.00	1.00
Exposure to Tariff	571893	0.07	0.07	0.00	1.75
Exposure to B14	602081	0.25	0.33	0.00	1.00
Exposure to B7	602081	0.10	0.24	0.00	1.00
Exposure to C1	602081	0.21	0.30	0.00	1.00
Exposure to C3	602081	0.02	0.14	0.00	1.00
logexport	854318	0.14	11.65	-13.82	19.70
logRER	854318	2.73	0.04	2.66	2.80

The table shows the summary statistics of the firm-level competition index defined in equation 2 for the initial time period in the analysis (2014), the NTM and tariff exposure measures defined in equations 3 and 4, the log value of exports and the real exchange rates for the period under study (2014-2018).

We are interested in the coefficients α_2 and α_3. α_2 captures the differences in the elasticity of exports to exchange rates between two firms who face exactly the same level of Chinese competition, but different levels of NTMs on imported inputs. α_3 captures the differences in the elasticity of exports to exchange rates between two firms that face exactly the same level of Chinese competition but different levels of tariffs on imported inputs. While NTMs can be justified from a public policy perspective (see further discussion below), they create a fixed cost for firms that rely on imported inputs to comply with regulatory requirements, thus making it more difficult to adjust the input composition and reducing the resilience of firms' responses to sudden changes in competition conditions in third markets. As a result, we would expect these NTMs to reduce the export response of firms during the many episodes of rapid yuan-USD exchange rate movements that affect the competition conditions in Japan observed during the period under study (i.e. we expect α_2 to be negative). In contrast to NTMs, tariffs affect the variable costs of importing inputs which reduce the volumes of imported inputs but do not create fixed costs for importing firms. As a result, we do not expect tariffs to have a systematic impact on the export resilience of Indonesian firms to yuan-USD exchange rate shocks (i.e., we expect α_3 not to be significant).

4.2 Endogeneity concerns

The ideal scenario for identification requires the interaction between the export demand shock and the trade measure to be exogenous to product exports at the firm level. While the demand shock is arguably exogenous to the firm, that may not be the case for the trade policy variables. In fact an ample literature documents the sizable influence of firms and sectors on trade protection (Grossman and Helpman, 1994; Goldberg and Maggi, 1999; Bombardini and Trebbi, 2012).

Our setup is able to address this endogeneity of trade measures through S_{it} and γ_{gt}, which capture all firm-time and product-time characteristics, respectively. This extensive set of fixed effects can control for any time-varying shocks at the firm or product level that may drive both export outcomes and our identifying variable. In the same vein, such controls would address possible reverse causality issues, including firm- or sector-level lobbying efforts.

These controls imply that identification comes from two comparisons: (i) between different products within a firm on the basis of the degree of export demand shock and (ii) between different firms exporting the same product on the basis of the degree of firm-specific trade exposure. Given the likely exogeneity of the export demand shock, the key endogeneity concern comes from (ii). To relieve that concern the trade exposure measures — as defined in equations 3 and 4 — are constructed using time invariant weights based on the firms' import shares at baseline. Using the baseline import shares addresses the concern that if firms substituted away from imports subject to NTMs for imports that were not, we would be underestimating the firms' exposure to NTMs.

To address the remaining endogeneity concerns, we also perform two further tests. First, we add in the vector of controls the baseline firm-level export share in total Indonesian exports of each of the products interacted with time effects. This should capture firms' ability to affect trade barriers on inputs on the basis of the firms' importance in the exports of products using those inputs. Along similar lines, the second test excludes the dominant exporters of specific products.

5 Results

5.1 Main Results

Table 2 below reports the results from estimating equation 1, using the aggregate NTM measure. The results across the three specifications, using a wide array of fixed effects, show that firms that face NTMs suffered a larger fall in exports in response to exchange rate shocks compared to firms that did not face NTMs, given the level of exposure to Chinese

competition. The most strict specification, including all the fixed effects at the product, time, and firm level and their interactions, is presented in column (3). While the signs of the effects of NTMs and tariffs do not depend on what sets of fixed effects we include, the magnitudes do. For example, it is important to control for firm-time fixed effects to address possible reverse causality issues, such as firm level lobbying efforts.

Table 2: Effect of exchange rate shocks on Indonesian exports in Japan

	Dependent Variable : log exports		
	(1)	(2)	(3)
α_2 (NTM)	-0.2414**	-1.0293**	-1.0293***
	(0.1148)	(0.4534)	(0.2592)
α_3 (Tariffs)	-0.0150	-0.0079	-0.0079
	(0.1197)	(0.3953)	(0.2725)
Firm-product FE	Yes	Yes	Yes
Product-time FE	Yes	Yes	Yes
Firm-time FE	No	Yes	Yes
Clustering	firm-level	firm-level	product-level
Mean Exposure	0.428	0.428	0.428
Adjusted R2	0.993	0.993	0.993
N	303,348	249,043	249,043

Standard errors are clustered at the firm level. The variable "NTMs" includes all NTMs in Indonesia. The table reports the results of estimating equation 1 where all NTMs under study are combined. *** p<0.01, ** p<0.05, * p<0.1.

Since the estimated coefficients are all elasticities, the magnitude of estimated effects are best illustrated with an example. In equation 1, taking derivatives on both sides with respect to the exchange rate of USD vis-a-vis yuan, we derive an expression for the elasticity of the value of exports with respect to the exchange rate. The differences in the elasticity of exports to exchange rate shocks between firms facing the exact same (mean) level of Chinese competition but different levels of NTM exposures are given below:

$$\epsilon_{v,Ex,NTM_{75\text{th percentile}}} - \epsilon_{v,Ex,NTM_{25\text{th percentile}}} = \alpha_2 I_{ig}^{mean} \Delta(NTMExposure_{it}) \tag{5}$$

Consider a 10% devaluation in yuan. If we compare two firms, facing the exact same (mean) level of Chinese competition, the firm at the 75^{th} percentile of NTM exposure will see a 2% larger fall in exports than the firm at the 25^{th} percentile of NTM exposure.

Results in Table 2 also show that there is no corresponding effect of tariffs on firm-level exports. This is consistent with tariffs affecting only variable costs, and unless there

are drastic changes in tariffs, such as the 2018-2019 US import tariff changes studied by Handley et al. (2020), firms know exactly what to pay in tariff costs. Differently from tariffs, each specific type of NTM entails very distinct procedures of compliance which create uncertainties. While on average, all the NTMs analyzed here create fixed costs, there is large heterogeneity across NTMs, with each of them having specific aims and economic impacts. In the following section, we tease out some of this heterogeneity by examining in detail the effects of a number of individual NTMs, which we argue are particularly suitable to be studied.

We check the robustness of the results to addressing remaining endogeneity concerns as explained in section 4.2. In table 3 we add the firm-product pairs' baseline characteristics interacted with time-fixed effects. In column 1 we use the firm's share of HS-4 exports in Indonesia's total exports as the baseline characteristic. The NTM coefficient remains very close to that in table 2, column 3. The coefficient also holds when using the firm's share in Indonesian HS-4 imports instead of exports (column 2) as well as both characteristics together (column 3).

Table 3: Robustness: Controlling for baseline characteristics

	Dependent Variable : log exports		
	(1)	(2)	(3)
α_2 (NTM)	-0.9047**	-0.9099**	-0.9107**
	(0.4514)	(0.4560)	(0.4556)
α_3 (Tariffs)	0.0830	0.0167	0.0514
	(0.3995)	(0.3649)	(0.3778)
Baseline import-share#time	No	Yes	Yes
Baseline export-share#time	Yes	No	Yes
Mean Exposure	.42	.42	.42
Adjusted R2	0.994	0.994	0.994
N	207,230	207,095	206,428

Standard errors are clustered at the firm level. The variable "NTMs" includes all NTMs in Indonesia. The table reports the results of estimating equation 1 where all NTms under study are combined. Columns (1) and (2) interact the firm's baseline import and export shares of HS-4 imports and exports in Indonesia's total imports and exports in the baseline year the firm appears in the data with time-fixed effects, respectively. Column (3) includes both interactions. All regressions include firm time, firm product, and product time FES. *** p<0.01, ** p<0.05, * p<0.1.

Further, in table 4 we check the robustness of the results to excluding particularly large exporters, which could exert an undue influence on trade policy. In column 1, we exclude exporter-product pairs in which the exporter's share in that HS4 exceeds the 99th percentile.

The absolute value of the NTM coefficient is only slightly below the baseline coefficient in table 2 and it is still significant at 10 percent. In column 2, we exclude exporters which are above the 99th percentile of exports - irrespective of what products they export. Again the coefficient is slightly smaller than the baseline and remains significant at the 5 percent level. Finally, our main result is robust also to excluding both sets of exporter-products and exporters (column 3).

Table 4: Robustness: Excluding top exporters

	Dependent Variable : log exports		
	(1)	(2)	(3)
α_2 (NTM)	-0.8596*	-0.8304**	-0.8982**
	(0.4559)	(0.4139)	(0.4430)
α_3 (Tariffs)	0.2030	0.2152	0.3019
	(0.4010)	(0.3797)	(0.3886)
Firm-product FE	Yes	Yes	Yes
Product-time FE	Yes	Yes	Yes
Firm-time FE	Yes	Yes	Yes
Clustering	firm-level	firm-level	firm-level
Mean Exposure	.45	.45	.45
Adjusted R2	0.994	0.994	0.994
N	198,314	195,825	190,047

Standard errors are clustered at the firm level. The variable "NTMs" includes all NTMs in Indonesia. The table reports the results of estimating equation 1 where all NTMs under study are combined. Column (1) excludes the top exporter-product pairs in the specific HS-4 that the firm exports. Column (2) excludes the top exporters, as measured by the total value of exports, irrespective of what goods they export. Column (3) excludes both. Top exporters of a particular HS-4 product are defined as firms whose share of HS-4 exports in Indonesia's total exports are above the 99th percentile (about 15%) of all firm-level shares defined in the baseline year the firm appears in the data. Top exporters are defined the same way, but irrespective of the goods they export. All regressions include firm time, firm product, and product time FES. *** p<0.01, ** p<0.05, * p<0.1.

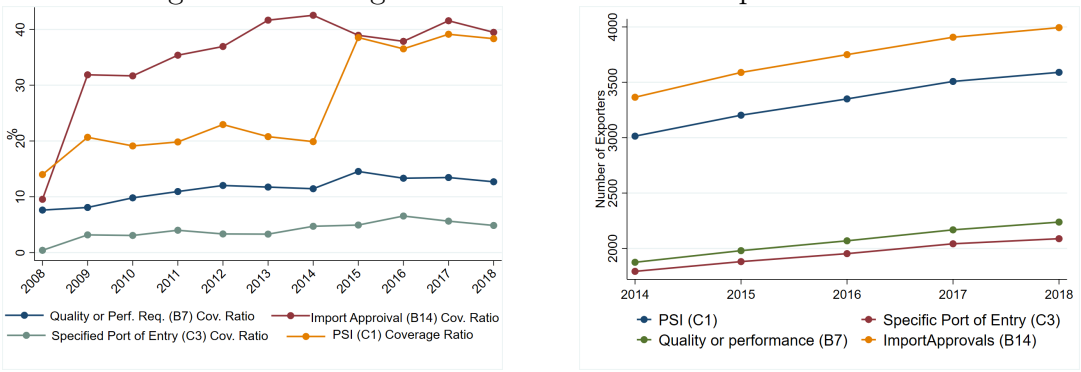
5.2 Trade distorting NTMs

The results so far show that NTMs reduce the resilience of exporters to exchange rate shocks. However in order to estimate the net economic effects of NTMs, we would also need to know the value of the negative externalities that they address, which we do not observe with the results for all NTMs discussed in the previous section. Indeed, a lot of NTMs are imposed to ensure product quality standards (Macedoni and Weinberger, 2022). For example, the measure coded as A22 in the MAST classification aims to protect the health of consumers

by establishing a permissible maximum residue of substances such as fertilizers, pesticides, and certain chemicals and metals in food and feed. Similarly, measure A86 imposes the requirement to detain or isolate animals, plants, or their products on arrival in a port or place for a given period to prevent the spread of infectious or contagious diseases or contamination.

In this subsection, we study the impact on exporters' resilience to foreign demand shocks of those NTMs that do not clearly address a negative externality. These measures may unnecessarily distort trade without having a well-defined public policy objective.[10] In this class of NTMs, we focus on the most common ones, i.e. those applied to products exported by at least a quarter of Indonesian exporters in the period of analysis. Applying these three conditions, i.e. (i) increasing import costs; (ii) not being necessary to achieve a well-defined public policy objective; (iii) being widely applied, allows us to identify four measures. These include —in decreasing order of product and exporters' coverage (Figure 3): Import Approval Requirements (IAR), Pre-Shipment Inspections (PSI), mandatory certification with Indonesian product standards or *Standar Nasional Indonesia* (SNI), and Port of Entry Restrictions (PER). Importantly for our purpose, all of these measures entail an increase in uncertainty around the import procedures, as highlighted below.

Figure 3: Coverage ratio and Number of Exporters Affected



a.Coverage Ratio b. No. of Firms Affected

Source: Author Calculations

Of all the firms that exported to Japan at least once between 2014 and 2018, around 59% were exposed to IAR (B14 in UNCTAD's MAST terminology), 55% to PSI (C1), 40% to SNI (B7) and 31% to PER (C3). We contend that each of them aims to achieve a non-trade objective that is already fulfilled or could be fulfilled through other less burdensome measures. Before moving to the analysis, we provide some additional information on each of these measures.

[10]The idea that NTMs should not unnecessarily harm trade is embedded in the WTO agreements. Specifically, NTMs are in contrast with WTO rules if: (i) they discriminate against imports; (ii) they are not necessary to achieve a non-trade objective; and (iii) they are likely to impose significant costs on imports.

Import Approval Requirements

The first measure is *Import Approval Requirements* (B14). This is issued by the Ministry of Trade, with supporting specific recommendations from related ministries, before the product can be imported. These letters aim to fulfill non-trade objectives, which are often related to the protection of domestic producers in the sector. Ministries have relatively high discretion in deciding on the recommendation, including whether or not to grant it, how long it takes for them to respond and the quantity allowed for the specific approval, which can differ from what the producer requested. When the import approval aims to protect producers, this NTM does not seem to comply with the WTO principle that "any person fulfilling the legal requirements should be equally eligible to apply for and obtain import licenses" (WTO GATT, Article 2.1).

Pre-Shipment Inspection

The second measure *PSI* requires shipments to be inspected at the port of departure from the exporting country before leaving for Indonesia. The objective of PSI is to ensure that the import declaration lists the correct classification of the goods to be imported as a way of detecting improper importing activities. This measure appears redundant in a country like Indonesia, where the customs agency applies a risk management system aiming to detect suspicious shipments at the border. In Indonesia, only two State-Owned Enterprises (SOEs) have the authority (granted by the Ministry of Trade) to perform PSI for the Indonesian government. The SOEs at times further outsource the inspection to other companies. A surveyor report outlining the surveyor firm's inspection results is a documentary requirement for certain goods. Anecdotal evidence suggests that such limited supply of inspection agencies increases the uncertainty around the time it takes to comply with such a procedure.

Besides the fees for this service, this can increase the cost of importing by increasing the uncertainty on the time to import and the compliance costs for imports.[11] Additionally, Indonesia is the only country that requires PSI in Southeast Asia and among other middle-income countries. Calì and Montfaucon (2021) find that a 1% increase in exposure to pre-shipment inspections leads to a 0.6% drop in export values in Indonesia, while Jose et al. (2006) find evidence that suggests that PSI increases under-invoicing in Indonesia.

[11]Some evidence was gathered from interviewing companies directly in Indonesia. For instance, we find that only 1 OECD country applies this measure. Additionally, Calì et al. (2021) find that this measure reduces productivity and increases domestic markups in the manufacturing product markets to which it is applied.

Compliance with National Standards

The third measure is *compliance with national standards SNI* (B7), which countries typically require to ensure the safety of the users of the goods. In Indonesia, this is mandatory for a wide range of manufacturing goods. As certification requires a visit to the factory premises by an Indonesian certifying agency, the cost is considerably higher for imported goods. The monetary cost is compounded by the uncertain duration of the process. In addition, a lack of harmonization with international standards could also limit exports for Indonesia for more products with a global standard (e.g., medical equipment). Renewing SNI can also be unpredictable and lacks transparency.

Besides being complex, the incidence of the compulsory certification procedure is also particularly widespread in Indonesia as it is applied to thousands of products in our sample period, which do not present major safety risks for consumers. These include several intermediate inputs, such as light bulbs, steel rods, and tires, which are used by firms rather than final consumers. As such the application of this measure appears to unnecessarily restrict trade for many of these goods.

Port of Entry Restrictions

The final NTM relates to the obligation that certain imported goods must enter Indonesia through designated ports (C3), i.e. *port of entry restrictions*. This requirement is intended to ensure the safety of imported products by directing imports to ports that possess adequate screening facilities. However, this raises trade costs and increases prices in product markets as goods are not able to enter through their natural entry port according to market demand. This measure is applied to less than 6% of imports in the rest of the region, compared to about 20% in Indonesia.

NTM-specific results

These four NTMs are regulated by 11 different ministries and in some cases by government regulations. For instance, SNI (B7) regulations are issued by 8 different ministries. The list of ministries and number of regulations under each set of NTMs is provided in Table A2. Since 2014 the government has applied these measures to an increasing number of products, although for some of them the percentage of import values subject to NTMs (their coverage ratio) has been on a downward trend in recent years. This may partly reflect importers' response to the measures (Figure 3 a). Figure 3 b also shows that the number of firms that export using at least one imported input affected by the four NTMs has been steadily increasing over time.

In order to understand the effects of these specific NTMs, we run specification 6 below, which we estimate separately for SNI certification, import-approval, pre-shipment inspection, and port of entry restrictions. The only difference with our main specification 1 is that when analyzing the effect of a specific NTM, we control for the exposure to the other types of NTMs that a firm faces.

$$\begin{aligned} ln(V_{igt}) = \beta 1 I_{ig} * ln(E^{China}_{USD,t}) + \beta_2 I_{ig} * ln(E^{China}_{USD,t}) * NTMExposure_{it} + \\ \beta_3 I_{ig} * ln(E^{China}_{USD,t}) * OtherNTMsExposure_{it} + \\ \beta_4 I_{ig} * ln(E^{China}_{USD,t}) * TariffExposure_{it} + f_{ig} + f_{it} + f_{gt} + \varepsilon_{igt} \end{aligned} \quad (6)$$

We are interested in the coefficients β_2, β_3, and β_4. To fix ideas, let's say pre-shipment inspection (PSI) is the NTM under consideration. β_2 captures the differences in the elasticity of exports to exchange rates between two firms who face exactly the same level of Chinese competition, but different levels of PSI. Then β_3 captures the differences in the elasticity of exports to exchange rates between two firms who face exactly the same level of Chinese competition, but different levels of all NTMs other than PSI. This helps us quantify if the different NTMs have heterogeneous effects on firms' responses to exchange rate shocks, after controlling for the effects of other NTMs.

Table 5 below reports the results from estimating equation 6. Columns (1),(2),(3), and (4) report the results of estimating equation 6 separately for SNI certification, Import approvals, PSI, and Port of entry restrictions, respectively. The results are broadly consistent with our hypothesis above. When faced with a sudden demand shock, firms whose inputs were subject to three out of four NTMs (SNI certification, import approvals, and PSI) experienced a larger drop in the value of their exports compared to firms that did not face NTMs, for any given the level of exposure to Chinese competition.

Table 5: Effect of exchange rate shocks on Indonesian exports in Japan: NTM breakdown

	Dependent Variable : log exports			
	(1)	(2)	(3)	(4)
β_2 (NTM)	-1.7479***	-0.9933**	-1.0094**	-1.0876
	(0.6217)	(0.4447)	(0.4776)	(0.9613)
β_3 (All other NTMs)	-0.7764*	-1.0744**	-1.0471**	-1.0264**
	(0.4330)	(0.5286)	(0.4689)	(0.4502)
β_4 (Tariff)	0.0237	0.0043	-0.0051	-0.0088
	(0.3929)	(0.3966)	(0.3970)	(0.3955)
Mean Exposure	0.097	0.230	0.203	0.020
Adjusted R2	0.993	0.993	0.993	0.993
N	249,043	249,043	249,043	249,043

Columns (1) (2), (3), and (4) show the effects of SNI certification, import approval, pre-shipment inspection, and port of entry respectively, controlling for the effects of all other NTMs, on the exports of Indonesian firms (results of estimating equation 6). Standard errors clustered at the firm level. All regressions include firm time, firm product and product time FES. *** p<0.01, ** p<0.05, * p<0.1.

Considering a 10% devaluation in the yuan, we find that firms in the $90th$ percentile of NTM exposure face a 2.14%, 1.97%, 1.61% and negligible (.006%) decline in exports compared to the firm with the median level of NTM exposure when the NTM in question is SNI certification, import approval, pre-shipment inspection, and port of entry restriction respectively. Given that the median firm faces no exposure to the port of entry NTM and the average exposure of firms to the port of entry NTM is 5 to 10 times lower than the other three NTMs, it is not surprising that this NTM hardly affects firm response. The effects of tariffs remain insignificant across all four specifications.

The fixed-cost nature of these measures makes it more costly for firms to switch imported inputs to swiftly adjust their exports in the case of a sudden demand shock. Moreover, these four NTMs lack transparency and predictability, thereby causing uncertainty which contributes to high costs. For example, by increasing the uncertainty in the timing of import delivery (Calì et al., 2021), PSI could make it difficult for exporters to procure the necessary inputs on time to cope with the changing competition conditions.

This uncertainty is particularly striking for a measure like SNI certification. This is required for any firm wanting to change an input supplier, which is typically the case in response to a shock if that HS code is subject to this requirement. The certification procedure is likely more costly, time-consuming and unpredictable than the process involved in the other three measures. It involves multiple steps and agencies and can typically take

4-5 months.[12]

In section 5.3 we tease out some of the heterogeneity of these effects across exporters, which also allows us to explore some key mechanisms explaining the negative effects of NTMs on exports in the face of sudden demand shocks.

5.3 Mechanism

A depreciation of the yuan changes the competitiveness and thus the demand for Indonesian exports. Indonesian firms need to adjust their supply in response to the changing demand, and thus need to adjust their inputs. The results so far indicate that NTMs make it harder for firms to adjust their inputs, thus negatively affecting exporters' resilience to foreign demand shocks. In this subsection, we investigate more closely this mechanism. We would expect this negative effect to be more prominent in firms that are less flexible. We consider in turn three possible sets of such firms, i.e. smaller firms, firms that import inputs less frequently on average, and firms that produce higher quality goods, as proxied by a higher unit value.

Less flexible exporters

We test if less flexible exporters are more negatively affected by the presence of NTMs on their imported inputs. First, we look at firms that are less frequent importers, as measured by the average number of months it takes the firm from one import activity to the next, are more negatively affected by NTMs.[13] From Table 6, we see that again with the exception of SNI certification, none of the NTMs negatively affect firms who are more flexible in terms of when they can import.[14]

Second, firms that are small on average have fewer trading partners, and hence are less flexible in terms of input sourcing (Bernard and Moxnes, 2018; Kashiwagi et al., 2018). We define small firms as firms that have exports below the median value of exports for all Indonesian firms exporting to Japan. Table 7 shows that with the exception of SNI certification NTM again, firms with above median market share are not affected by NTMs. However, all the NTMs negatively affect the exports of small firms.

Finally, firms that produce higher quality goods, as proxied by the unit value, may require special inputs that are less easily substitutable (Kugler and Verhoogen, 2012; Blaum et al., 2019). In this case, NTMs can affect firms producing higher quality output more negatively as they will have a harder time adjusting their output to sudden demand shocks.

[12] See figure A1 in the appendix

[13] We define firms as less frequent importers if their importing frequency is below the median.

[14] The coefficient on the product-conformity requirement for firms that import more frequently is $\frac{2}{25}$ times the coefficient on the product-conformity requirement for firms that import less frequently.

In Table 8 we find that while firms that produce higher quality output, as proxied by the unit value, are negatively affected by NTMs, firms producing lower quality goods, in general, are not affected by NTMs, with the exception of SNI certification.

Table 6: Effect of exchange rate shocks on Indonesian exports in Japan: Heterogeneity by importing frequency

	Sample A: Firms with below median importing frequency			
	Dependent Variable : log exports			
	(1)	(2)	(3)	(4)
β_2 (NTM)	-6.9459*	-4.4577***	-4.9686***	-10.2854***
	(4.0770)	(1.6944)	(1.8420)	(2.5788)
β_3 (All other NTMs)	-4.2924***	-4.3318**	-3.7857**	-3.2389***
	(1.5729)	(1.9842)	(1.6290)	(1.2327)
β_4 (Tariff)	0.6236**	0.5533**	0.4631*	0.5357**
	(0.2458)	(0.2704)	(0.2380)	(0.2106)
Mean Exposure	0.096	0.217	0.185	0.014
Adjusted R2	0.991	0.991	0.991	0.991
N	147,767	147,767	147,767	147,767
	Sample B: Firms with above median importing frequency			
	Dependent Variable : log exports			
	(1)	(2)	(3)	(4)
β_2 (NTM)	-0.5890*	-0.1706	-0.0371	0.3300
	(0.3018)	(0.2777)	(0.2952)	(1.0193)
β_3 (All other NTMs)	0.0800	-0.0680	-0.2037	-0.1385
	(0.2747)	(0.3018)	(0.2433)	(0.2316)
β_4 (Tariff)	-0.0230	-0.1162	-0.1075	-0.0901
	(0.5552)	(0.5743)	(0.5757)	(0.5724)
Mean Exposure	0.098	0.243	0.222	0.025
Adjusted R2	0.986	0.986	0.986	0.986
N	87,059	87,059	87,059	87,059

Columns (1) (2), (3), and (4) show the effects of SNI certification, import approval, pre-shipment inspection, and port of entry respectively, controlling for the effects of all other NTMs, on the exports of Indonesian firms (results of estimating equation 6). Standard errors clustered at the firm level. All regressions include firm time, firm product and product time FES. *** p<0.01, ** p<0.05, * p<0.1.

Table 7: Effect of exchange rate shocks on Indonesian exports in Japan: Heterogeneity by market share

	Sample A: Firms with below median market share			
	Dependent Variable : log exports			
	(1)	(2)	(3)	(4)
β_2 (NTM)	8.0619	-6.9539***	-5.3944**	-7.3868***
	(9.6031)	(2.2840)	(2.2232)	(2.5022)
β_3 (All other NTMs)	-5.5760**	-3.9681	-5.6381**	-5.3229**
	(2.3312)	(2.5763)	(2.8527)	(2.3311)
β_4 (Tariff)	0.2470	0.2329	0.2823	0.2556
	(0.9270)	(0.9397)	(0.9313)	(0.9279)
Mean Exposure	0.090	0.213	0.186	0.014
Adjusted R2	0.990	0.991	0.990	0.990
N	128,210	128,210	128,210	128,210
	Sample B: Firms with above median market share			
	Dependent Variable : log exports			
	(1)	(2)	(3)	(4)
β_2 (NTM)	-1.0962**	-0.4750	-0.5416	0.7568
	(0.5032)	(0.3789)	(0.4106)	(1.3269)
β_3 (All other NTMs)	-0.3666	-0.7124*	-0.6170*	-0.6342*
	(0.3641)	(0.4211)	(0.3664)	(0.3568)
β_4 (Tariff)	0.0959	0.1075	0.0759	0.0803
	(0.3722)	(0.3676)	(0.3743)	(0.3729)
Mean Exposure	0.106	0.248	0.222	0.025
Adjusted R2	0.989	0.989	0.989	0.989
N	107,556	107,556	107,556	107,556

Columns (1) (2), (3), and (4) show the effects of SNI certification, import approval, pre-shipment inspection, and port of entry respectively, controlling for the effects of all other NTMs, on the exports of Indonesian firms (results of estimating equation 6). Standard errors clustered at the firm level. All regressions include firm time, firm product and product time FES. *** p<0.01, ** p<0.05, * p<0.1.

Table 8: Effect of exchange rate shocks on Indonesian exports in Japan: Heterogeneity by export prices

	Sample A: Firms with below median unit value			
	Dependent Variable : log exports			
	(1)	(2)	(3)	(4)
β_2 (NTM)	-1.4113*	-0.1670	-0.1517	0.3048
	(0.7399)	(0.6684)	(0.6287)	(1.4397)
β_3 (All other NTMs)	-0.0312	-0.7149	-0.7420	-0.4963
	(0.5836)	(0.6692)	(0.5892)	(0.5498)
β_4 (Tariff)	0.1022	0.1837	0.1829	0.1467
	(0.4936)	(0.4719)	(0.4634)	(0.4598)
Mean Exposure	0.104	0.241	0.218	0.022
Adjusted R2	0.995	0.995	0.995	0.995
N	104,917	104,917	104,917	104,917
	Sample B: Firms with above median unit value			
	Dependent Variable : log exports			
	(1)	(2)	(3)	(4)
β_2 (NTM)	-2.3615**	-1.4375***	-1.4959**	-3.1360***
	(1.0242)	(0.5378)	(0.5855)	(0.9846)
β_3 (All other NTMs)	-1.1985**	-1.3923*	-1.3545**	-1.3097**
	(0.5317)	(0.7385)	(0.6338)	(0.5797)
β_4 (Tariff)	-0.1235	-0.2290	-0.2360	-0.2452
	(0.5805)	(0.5817)	(0.5824)	(0.5815)
Mean Exposure	0.091	0.220	0.191	0.017
Adjusted R2	0.992	0.992	0.992	0.992
N	129,985	129,985	129,985	129,985

Columns (1) (2), (3), and (4) show the effects of SNI certification, import approval, pre-shipment inspection, and port of entry respectively, controlling for the effects of all other NTMs, on the exports of Indonesian firms (results of estimating equation 6). Standard errors clustered at the firm level. All regressions include firm time, firm product and product time FES. *** p<0.01, ** p<0.05, * p<0.1.

To sum up, in this section we provide evidence that NTMs primarily affect producers by reducing their flexibility to adjust inputs to demand shocks. Large firms, firms that import goods more frequently, or firms that produce lower-quality goods are less affected by NTMs. It is though important to note that SNI certification is the exception, as this regulation negatively affects firms of all types.

5.4 Robustness

In this section, we address two main concerns that can undermine our empirical strategy.

Firms that source inputs from China

Chinese exchange rate shocks such as depreciation can also make Chinese inputs cheaper in Indonesia. Results in the previous section could in principle be affected by the fact that some firms source their inputs from China or some products rely to a large extent on Chinese inputs in production. The firm-time and product-time fixed effects should control for these types of problems. As an alternative, we run a second type of specification, where we control for a firm-time level measure of exposure to Chinese input share. This measure is defined as the proportion of intermediate inputs, as defined by the BEA classification, that is sourced from China.[15]

The results of this robustness exercise are reported in Table 9. We can see that even in this modified specification, taking into account the Chinese input share, all the NTMs have a negative and significant effect on the exports of firms whose imports face such NTMs.

Table 9: Robustness: Controlling for Chinese input share

	Dependent Variable : log exports			
	(1)	(2)	(3)	(4)
β_2 (NTM)	-1.1744***	-0.5341**	-0.5529**	-0.5850
	(0.4387)	(0.2299)	(0.2425)	(0.5884)
β_3 (All other NTMs)	-0.4553**	-0.6376**	-0.6005**	-0.5761**
	(0.2179)	(0.2784)	(0.2522)	(0.2339)
β_4 (Tariff)	-0.2930	-0.3238	-0.3432	-0.3461
	(0.3970)	(0.4062)	(0.4086)	(0.4077)
Mean Exposure	0.428	0.428	0.428	0.428
Adjusted R2	0.993	0.993	0.993	0.993
N	312,358	312,358	312,358	312,358

Columns (1) (2), (3), and (4) show the effects of SNI certification, import approval, pre-shipment inspection, and port of entry respectively, controlling for the effects of all other NTMs, on the exports of Indonesian firms (results of estimating equation 6). Standard errors clustered at the firm level. All regressions include firm time, firm product and product time FES. Regressions control for the amount of inputs sourced from China at the firm level. *** p<0.01, ** p<0.05, * p<0.1.

[15]Note that, in this regression, we are unable to control for firm-time fixed effects as in the main specification since the china input measure is also defined at the firm-time level.

Controlling for Chinese firms' market power

China is an important presence in the Japanese market. On average, for the set of products that Indonesia exports to Japan, 32% of Japanese imports are from China. A depreciation in the yuan leads to a price reduction by Chinese firms, but the extent of exchange-rate pass-through depends on the market power of Chinese firms (Berman et al. (2012)). Since the effects of Chinese competition on Indonesian firms ultimately depend on the extent of exchange rate pass-through on prices, our results could be affected by the degree of Chinese firms' market power in different product markets. A priori, the link between Chinese market share, exposure to Chinese competition, and yuan depreciation is unclear. We use the 2011 Chinese firm-level data, the only year for which we have access to Chinese firm-level data, to compute the HHI share at the HS-6 level for Chinese firms who export to Japan. Similar to the competition index defined in 2 we define a measure of HHI that takes into account the market power of Chinese firms, defined below:

$$HHI_{ig} = \sum_{g'=1}^{G} \left(\frac{EX_{ig'}}{EX_{ig}} * HHI_{g'}^{China} \right) \tag{7}$$

where $\frac{EX_{ig'}}{EX_{ig}}$ measures the importance of HS-6 product g' in the total exports of the HS-4 product g exported to Japan by the Indonesian firm i; and $HHI_{g'}^{China}$ is the sum of squares of firm-level market-share for HS-6 product g' sold in the Japanese market by Chinese firms.

We modify our main specification 1 by adding the interaction of the real exchange rate variation with the HHI measure defined above. The results from our main specification do not change: All the NTMs under consideration negatively affect firms' export response. The positive and significant coefficient of the HHI measure interacted with exchange rate fluctuations in table 10 also provides suggestive evidence for the Berman et al. (2012) hypothesis that depreciations in Chinese exchange rate lead to a lower exchange rate pass-through for Chinese firms with higher market shares, as measured by the HHI, and thus lead to a lower fall in export values of Indonesian firms in markets with higher Chinese HHI. Even though interesting in its own right, since this is not a focus of our paper, we relegate further discussion of this to Appendix A3.3.

Table 10: Robustness: Controlling for Chinese firm's concentration index

	Dependent Variable : log exports			
	(1)	(2)	(3)	(4)
HHI#Exchange rate	1.3841***	1.3627***	1.3628***	1.3643***
	(0.3756)	(0.3736)	(0.3737)	(0.3742)
β_2 (NTM)	-1.7851***	-0.9389**	-0.9494**	-1.1634
	(0.6128)	(0.4318)	(0.4628)	(0.9663)
β_3 (All other NTMs)	-0.6829*	-1.0107**	-0.9898**	-0.9611**
	(0.4145)	(0.5128)	(0.4545)	(0.4340)
β_4 (Tariff)	0.0327	0.0076	-0.0002	-0.0061
	(0.3834)	(0.3890)	(0.3888)	(0.3875)
Mean Exposure	0.428	0.428	0.428	0.428
Adjusted R2	0.993	0.993	0.993	0.993
N	249,043	249,043	249,043	249,043

Columns (1) (2), (3), and (4) show the effects of SNI certification, import approval, pre-shipment inspection, and port of entry respectively, controlling for the effects of all other NTMs, on the exports of Indonesian firms (results of estimating equation 6). Standard errors clustered at the firm level. All regressions include firm time, firm product and product time FES. Regressions control for Chinese firms' market power by computing the HHI share at the HS-6 level for Chinese firms who export to Japan. *** p<0.01, ** p<0.05, * p<0.1.

6 Conclusion

This paper empirically investigates how a country's own trade policy affects firms' resilience to economic shocks. We first show that NTMs on imported inputs, more than tariffs, affect exporters' resilience as they make adjustments in production more difficult in response to foreign demand shocks. We then focus on four individual NTMs that we argue unnecessarily restrict trade and find that they make it more difficult for firms to respond to sudden changes in foreign demand and that the effects differ according to the type of NTM and the type of firm. NTMs mostly affect firms that are less flexible (i.e. small firms, firms importing less frequently, and firms producing higher-quality goods). These results are consistent with the idea that NTMs create fixed trade costs that interfere with the adjustment process firms need to cope with differing competition conditions in third markets.

The findings in this paper have clear policy implications. They suggest that there are gains to phasing out certain types of NTMs which unnecessarily restrict trade as a means to improving firms' resilience to economic shocks. These reforms would be primarily effective in promoting the resilience of firms that participate in global value chains, small firms, and

firms that specialize in high-quality products. These reforms, which aim at improving firms' resilience by reducing the policy constraints they face, are especially important in light of the current COVID-19 crisis and the need for firms to improve their preparedness in a world that appears to be characterized by more frequent and severe economic shocks.

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Appendix

A1.1 Data

Table A1: Invoicing Currency Shares of Indonesia in Exports

	USD	EUR	Home	Other	Unclassified	Other
2010	93.9	1.1	0.7	3.2	1.0	5.0
2011	93.6	1.0	0.7	3.4	1.2	5.3
2012	92.9	1.1	0.6	3.9	1.5	6.1
2013	93.8	0.9	0.7	3.1	1.4	5.2
2014	93.7	1.2	0.8	2.9	1.5	5.2
2015	94.0	1.2	1.1	2.9	0.9	4.8
2016	93.6	1.2	1.4	2.9	0.8	5.2
2017	94.4	1.1	1.4	2.3	0.8	4.5
2018	94.2	1.0	1.4	2.3	1.1	4.8

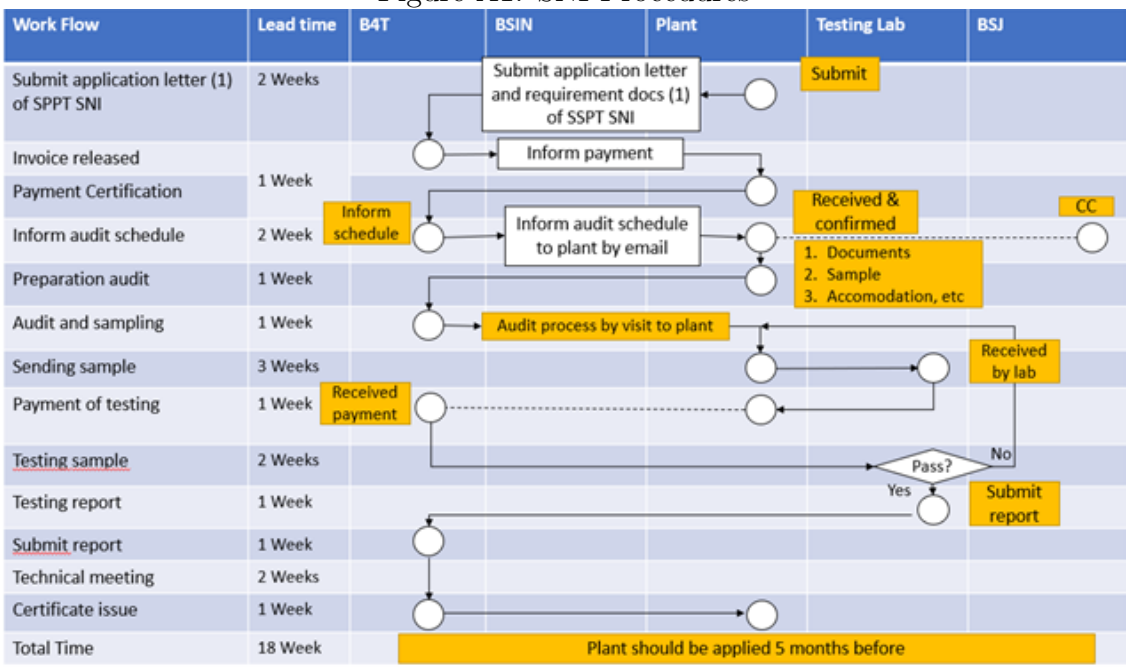
Source: Boz et al. (2020)

Table A2: Number of Regulations by Ministry in the For NTMs

Govt Agency	B14	B7	C1	C3	Total
		2014			
Total	12	19	10	15	56
GoI	2				2
MoA				4	4
MoI		17			17
MoMF	1	1		3	5
MoT	9	1	10	8	28
		2015			
Total	13	36	10	6	65
BPOM	2				2
INP	1				1
MoA		1			1
MoCI		6			6
MoI		28			28
MoMF				1	1
MoT	10		10	5	25
MoTr		1			1
		2016			
Total	18	10	13	8	49
BPOM	2				2
MoA	1			2	3
MoCI		1			1
MoI		7			7
MoMF				2	2
MoT	15	2	13	4	34
		2017			
Total	21	3	15	7	46
BPOM	4				4
MoA				2	2
MoEF	2				2
MoI		1			1
MoMF		2		1	3
MoT	15		15	4	34
		2018			
Total	24	9	20	10	63
MEMR		1			1
MoA		1		1	2
MoI		4			4
MoMF				2	2
MoT	24	3	20	7	54

Note:BPOM=National Agency of Drug and Food Control; GoI=Government of Indonesia; INP=Indonesian National Police; MEMR=Ministry of Energy and Mineral Resource; MoA=Ministry of Agriculture; MoCI=Ministry of Communication and Information; MoEF=Ministry of Environment and Forestry; MoH=Ministry of Health; MoI=Ministry of Industry; MoIT=Ministry of Industry and Trade; MoMF=Ministry of Marine Affairs and Fishery; MoT=Ministry of Trade; MoTr=Ministry of Transportation. Source: World Bank Jakarta NTM data

Figure A1: SNI Procedures



Source: Authors' elaboration on the basis of firms' interviews

A2.2 Supplementary analysis

We test whether NTMs and tariffs have a differential effect on the number of product-country pairs a firm sources its imports from in equations 8 and 9 below.

$$ln(N_{it}) = \gamma_i + \gamma_t + \gamma_2 NTMExposure_{it} + \gamma_3 TariffExposure_{it} + \eta_{it} \tag{8}$$

N_{it} is the number of hs-8 product-country combinations that a firm i imports at time t. An example value here would be newsprint imported from Germany by firm i in March 2019. $NTMExposure_{it}$ and $TariffExposure_{it}$ are measures of exposures of firm i to NTMs and tariffs as defined in section 4. We control for firm and time fixed effects. Robust standard errors, adjusted for heteroscedasticity, are used.[16]

$$ln(N_{it}) = \kappa_i + \kappa_t + \kappa_2 NTMExposure_{it} + \kappa_3 OtherNTMsExposure + \kappa_4 TariffExposure_{it} + e_{it} \tag{9}$$

In table A3 below, we show the results of these two types of specifications. Reading off column (1), we see that for every SD deviation increase in NTM exposure (0.26), firms

[16] We do not cluster standard errors at the firm level because the median firm only shows up 9 times in our data, and this is too small to yield consistent estimates of cluster robust standard errors (Baum, Nichols, Schaffer, et al., Baum et al.)

face a 1% decline in the number of HS-8 product country pairs that they export to. This effect is 3.57%, 1.87%, 1.17%, and 1.22% respectively for SNI certification, import approval, pre-shipment inspection, and port of entry respectively for every SD increase in NTM.[17]

Table A3: Relationship between NTMs, tariffs and the number of source country-import pairs

	Dependent variable : log product country pairs				
	(1)	(2)	(3)	(4)	(5)
γ_2 (Combined NTMs)	-0.0388***				
	(0.0147)				
Tariffs	0.0194	0.0195	0.0047	0.0179	0.0194
	(0.0307)	(0.0307)	(0.0308)	(0.0307)	(0.0307)
κ_2(NTM)		-0.0956***	-0.0648***	-0.0501***	-0.0672*
		(0.0354)	(0.0156)	(0.0189)	(0.0350)
κ_3(All other NTMs)		-0.0375**	0.0240	-0.0296*	-0.0385***
		(0.0148)	(0.0180)	(0.0163)	(0.0147)
N	171563	171563	171563	171563	171563
Mean Exposure:	0.473	0.109	0.289	0.234	0.041

Columns (1) (2), (3), (4) and (5) show the effects of an average of all NTMs combined, and then the effects of SNI certification, import approval, pre-shipment inspection, and port of entry respectively, on the exports of Indonesian firms. Columns (2),(3),(4), and (5) control for the effects of all other NTMs. Robust standard errors are used. All regressions include firm and time fixed effects.

A3.3 Suggestive evidence for Berman et al. (2012) hypothesis

Table A4 shows the correlation between the exposure of Indonesian firms to Chinese import competition measures as defined in equation 2 and to Chinese firm level concentration as measured by the HHI index defined in 7, after controlling for HS-4 product fixed effects. The high positive correlation at the firm level suggests that markets in which China has a high market share have a significant overlap with markets in which few Chinese firms control most of the market share. This correlation shows that researchers should exercise caution in interpreting how depreciations in Chinese currency affect competitor firms: On the one hand, higher exposure to Chinese competition means that firms in these markets face a tougher price competition as firms pass-through some of the exchange rate depreciations into product prices. On the other hand, since in the same markets few Chinese firms control

[17]The values of these SDs are 0.26, 0.37, 0.34, and 0.18 respectively for SNI certification, import approval, pre-shipment inspection, and port of entry.

a higher market share, the exchange rate pass-through into prices is lower, implying less price competition for competitor firms. Table A5 below shows that unit prices of Indonesian firms fall less in response to Chinese exchange rate depreciations in markets with higher exposure to Chinese competition (column 1), higher exposure to Chinese market concentration (column 2), and in markets where the overall share of Chinese goods in a specific HS-4 category is larger compared to markets where these measures are lower. This also provides support for the Berman et al. (2012) mechanism that there is less pass-through of exchange rates into markets with higher market power of Chinese firms, and thus less fall in the prices of the products sold by Indonesian firms.

Finally, in Table A6 we show that our results on how Indonesian firms exports respond to exchange rate shocks in third country markets do not contradict the results in Mattoo et al. (2017). There are two important caveats when comparing our results to those obtained by Mattoo et al. (2017): First, our regressions are at the firm-level and second, we use the exchange rate between the yuan and USD rather than the yuan and yen as the vehicle currency of invoicing for Indonesian firms is USD (Table A1). In fact, using the same country-level specification as in Mattoo et al. (2017) in Table A6 we show that exports of Indonesian products fall in markets that face higher Chinese competition.

Table A4: Correlation between Chinese competition measure and the measure of HHI

	(1)
	CI Japan
HHI Measure	0.3539***
	(0.0156)
Constant	0.3359***
	(0.0027)
Observations	199521

Standard errors in parentheses

Regressions include HS-4 product fixed effects

Standard errors are clustered at the firm level

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A5: Effect of exchange rate shocks on unit prices of Indonesian firms in Japan

	(1) logUnit price HS4	(2) logUnit price HS4	(3) logUnit price HS4
CI Japan × log yuan/USD real ex	0.2308***		
	(0.0422)		
HHI Measure × log yuan/USD real ex		0.1250**	
		(0.0561)	
Import share of Chinese goods (HS4) × log yuan/USD real ex			0.5127**
			(0.2402)
Constant	-0.3705***	-0.2593***	-0.8013***
	(0.0234)	(0.0075)	(0.2642)
Observations	330736	330736	344425

Standard errors in parentheses

Standard errors clustered at firm level

All regressions except column 3include firm, product, time, firm time, firm product and product time FES

Coulumn 3 does not control for product time FEs since the dependent variable is at product time level

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A6: Effect of real exchange rate shocks (yuan/yen) on Indonesian exports in Japan at the country level

	(1) logexport
CI Japan × log yuan/ yen real ex	-7.5298***
	(0.1935)
Constant	3.4016***
	(0.1428)
Observations	5092

Standard errors in parentheses

Robust standard errors are used

All regressions include product, time, and product time FES

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$