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How Did the 2003 SARS Epidemic Shape Chinese Trade?

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How Did the 2003 SARS Epidemic Shape Chinese Trade?

Abstract

This paper examines the impact of the Severe Acute Respiratory Syndrome (SARS) epidemic on China's trade. Using quarterly transaction-level trade data of all Chinese firms, we find that firms in regions with local transmission of SARS experienced lower import and export growth at both the intensive and extensive margins, compared to those in the unaffected regions. The affected firms' trade growth remained lower two years after SARS. Products that are more capital-intensive, skill-intensive, upstream in the supply chains, and differentiated experienced a smaller export decline but a stronger recovery. Small exporters were more likely to exit, slowing down trade recovery.

JEL-Codes: F120, F140.

Keywords: Covid-19, SARS, trade collapse, post-pandemic recovery, natural disasters, disruption, global supply chains.

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1 Introduction

The Covid-19 pandemic has disrupted the global economy and supply chains.[1] The World Trade Organization (WTO) forecasts a global trade decline of up to 32% in 2020, more than double the magnitude of the "Great Trade Collapse" during the 2008-2009 global financial crisis (WTO, 2020). While the pandemic is still evolving and its end remains uncertain, there should be important lessons that one can draw from a similar episode in the past to shed light on the upcoming trade slump and eventual recovery. How severe is the 2020 trade collapse likely to be? How long will it take to recover? Which sectors will be most affected? What types of firms will be most impacted?

This paper exploits the 2003 Severe Acute Respiratory Syndrome (SARS) epidemic that hit various regions in China to shed light on these questions. Using a standard difference-in-differences research design, we assess the impact of SARS on firms' export and import performance in the affected regions in China, relative to those in the unaffected regions. Despite the apparent differences, there are clear advantages from using the SARS epidemic to shed light on the trade outcomes of the Covid-19 pandemic. First, the sudden and abrupt travel and trade disruption triggered by the unexpected outbreak of SARS, similar to the situations during the Covid-19 pandemic, offer a unique opportunity for an event study on the effect of a health crisis on global trade. Second, the fact that the outbreaks of SARS are clustered mostly in China, unlike Covid-19 which is a global crisis, allows us to clearly categorize Chinese firms into the treatment and control groups. Third, the relatively short duration of the SARS epidemic permits an analysis on the recovery path of trade when it is eventually over.

It is worth noting that despite the much weaker impact on global health, SARS serves as a relevant benchmark to draw lessons for Covid-19 in terms of the impact on trade. Because of the high death rate,[2] the fear created by SARS among consumers, investors, and businesses in the affected regions, together with the policy responses that disrupted travel and trade, could have resulted in local economic losses comparable in size to those triggered by Covid-19. More importantly, SARS has halted business travels and activities for two quarters in 2003 in the affected

[1] The International Monetary Fund forecasts that global GDP will decline by at least 3% in 2020, in the best-case scenario, with the loss likely to be significantly worse.

[2] When the SARS epidemic ended and concluded in the third quarter of 2003, the global death rate, defined as the ratio between the cumulative number of SARS-related death to that of infections, is 9.2%. It is much higher than the death rates of the evolving Covid-19, according to the official statistics reported by all countries.

parts of China, potentially impacting Chinese trade in the medium run.

Using quarterly transaction-level trade data of all Chinese firms, we find that during the quarters of 2003 SARS epidemic, firms in regions (provinces and municipality cities) with local transmission experienced significant declines in both import and export growth, at both the intensive and extensive margins, relative to those in the unaffected regions. Both aggregate exports and imports started to recover by the fourth quarter of 2003, right after the end of the SARS epidemic, which was officially announced by the World Health Organization (WHO) in July 2003. That said, by the end of 2005, two years after SARS was over, firms' average export and import growth in the affected regions were still 4 and 6 percentage-points below the pre-SARS trend, respectively, relative to those in the unaffected regions. In other words, SARS had a medium-term effect on Chinese trade, contrasting the conventional view.

Moreover, we unveil the heterogeneous effects of SARS on trade performance across firms and products. Large and processing exporters, many of them being foreign-owned, are more likely to survive; and conditional on survival, large and processing exporters contributed to slower export growth during the post-SARS recovery in the affected regions. Products that are more capital-intensive, skill-intensive, upstream in the supply chains, and differentiated were more resilient to the export disruption caused by SARS, and drove export recovery afterwards. These findings are consistent with the hypothesis that products that are highly substitutable and widely available in other countries, such as mass-produced consumption goods and downstream low-tech products, could have replaced some Chinese exports permanently despite a temporary disruption of trade. Firms' imports in the affected regions also declined significantly during the epidemic and then rebounded right after the end of it, partly related to the dominance of processing trade in China in the early 2000s, in which firms' exports and imports are more interconnected.

With China's moving up the value chains in the past two decades and a more global and uncertain nature of Covid-19, the outcomes this time may well be different. China is now less dependent on processing exports, commanding a lot more in the upstream of various sophisticated supply chains, and more specialized in skill- and capital-intensive products. Based on our results, China may experience a smaller disruption or a faster recovery in both exports and imports due to the supply shocks caused by Covid-19, all else equal, as foreign buyers may not be able to find substitutes easily. However, the low substitutability of Chinese products can imply a larger

disruption of the supply chains, especially given the increased interdependence between firms and countries through global production sharing. Moreover, given that the pandemic is global, the propagation of demand or supply shocks when economies were shut down sequentially imply larger and prolonged effects of the pandemic on global trade.

This paper relates to several strands of literature. It adds to the large literature on trade fluctuations caused by economic recessions, in particular the 2008-2009 financial crisis (e.g., Baldwin, 2009; Bems, Johnson, Yi, 2010; Levchenko, Lewis, and Tesar, 2010; Chor and Manova, 2012).[3] It is also related to the quantitative analysis of the propagation of supply shocks originating from natural disasters (Barrot and Sauvagnat, 2017; Carvalho et al. 2017; Boehm et al., 2020).[4] Of note, Huang (2019) also examines the SARS epidemic on firms' input sourcing, focusing on firms' supply chain resilience based on their pre-crisis supplier diversification. Our paper has a more straightforward goal, which is to examine both the short-term and medium-term effects of SARS on firms' trade performance, as well as the potential heterogeneous effects across firms and products. These facts are important for understanding the pattern of the post-pandemic recovery of global trade, in the absence of escalating trade tension between countries. Finally, our work naturally contributes to the rapidly growing literature on the macroeconomic impact of the current coronavirus pandemic, by shedding light from the trade angle on which sectors and firms may be more affected or contribute to an eventual recovery.

2 Background of SARS

SARS was the first infectious coronavirus in the 21st century.[5] It infected over 8000 people and killed 774 globally (Chan-Yeung and Xu, 2003). It emerged in late 2002 from an outbreak of atypical pneumonia in Guangdong Province in China, and subsequently spread to 29 countries on

[3] See Bem, Johnson and Yi (2013) for a review of the literature on the determinants of the Great Trade Collapse in 2008-2009. The main determinants of the trade collapse and the slow recovery were attributed to the collapse in global demand, particularly for durable goods, and the deteriorated trade financing. The rise of protectionist policies was still not the main cause of the collapse or the slow recovery afterwards (Kee, Neagu, and Nicita, 2013).

[4] For instance, Barrot and Sauvagnat (2017) examine how supply shocks originating from Hurricane Katrina spillover over to firms throughout the U.S. through domestic supply chains. Boehm et al. (2020) show that the global automobile sector that is heavily dependent on the Japanese supply chains was significantly disrupted in the days right after the 2011 Tohoku earthquake, before a robust and immediate recovery. Using the same shock, Carvalho et al. (2017) quantify the role of input-output linkages in propagating and amplifying supply shocks in Japanese production networks.

[5] The second one is Middle East respiratory syndrome (MERS) in 2012. The third one is the Covid-19 pandemic in 2020.

five continents (Heymann et al., 2003). The majority of the infections and deaths were recorded in mainland China and Hong Kong, which together accounted for 87.5% and 80.0% of infections and deaths, respectively (WHO, 2004). Within China, the places that were hit the hardest are Guangdong, Beijing, Inner Mongolia, and Shanxi. In addition, all SARS epidemic outbreaks in Chinese regions ended in the third quarter of 2003, while most regions in China had the start of local transmission in the first half of 2003, with the exception of Guangdong. In short, SARS is a lot more local and short-lived than Covid-19. As discussed in the introduction, the geographic concentration and short duration of SARS actually make it more appealing as a natural experiment for an empirical study.

Like the 2020 coronavirus pandemic, the WHO officially declared the outbreak of SARS in different regions at different time in 2002-2003. We use such list provided by the WHO as quasi-natural experiments.

It is worth emphasizing that despite the smaller number of global infections and deaths, SARS remains a relevant benchmark to shed light on the potential disruptions of Covid-19 in trade and the macroeconomy. First, the SARS death rate, which was concluded to be 9.2% when the epidemic ended, is much higher than the death rates of the evolving Covid-19 reported in almost all countries. Hence, the fear among consumers, investors, and businesses in the affected regions, together with the policy reactions that disrupt travel and trade, could create losses in local economies that are comparable in size to those triggered by Covid-19. Second, it is important to note that the smaller geographic scope of SARS does not mean that it has an insignificant economic impact on the affected regions. According to Hanna and Huang (2004), China's GDP was estimated to contract by over 5% in the second quarter of 2003 on a seasonally adjusted annualized basis, which is equivalent to a 0.5% reduction in China's 2003 GDP.

Third, and probably most relevant for a study on trade, SARS has halted business travels and activities for two quarters in 2003 in the affected parts of China, potentially impacting Chinese trade in the medium run. Like the consequence of Covid-19, SARS has significantly disrupted domestic and international travels for the affected regions. On April 2, 2003, the WHO issued a travel advice to recommend people to postpone all non-essential travel to Hong Kong and Guangdong province. The same advice was extended to cover Beijing on April 23 and Tianjin and Inner Mongolia on May 8 in the same year. While air passenger travel data were not publicly available for individual cities

in mainland China for that period, the 65% and 68% declines in international passenger arrivals in Hong Kong in April and May in 2003 respectively can serve as a reliable inference for the extent of air travel disruption in the affected Chinese cities (Noy and Shields, 2019).

These disruptions in air travel could have medium and even long-term impacts on Chinese global trade. Research has shown that international business travels are highly correlated with the volume and composition of differentiated goods' trade (Cristea, 2011). An abrupt and sharp reduction in international travels and cancellation of business meetings, even for a few months, will have an impact on trade over a longer period. For instance, hundreds of thousands of buyers from around the world would travel to Guangzhou, the epicenter of SARS in 2003, to attend the annual Canton Fair to meet the Chinese sellers since 1957. Many long-term business relationships and trade orders were created in the fair. In April 2003, due to the WHO travel alerts and the fear among business travellers, only about 23,000 buyers attended the fair, a roughly 80% downturn from the previous year.[6] It is also widely believed that SARS, which caused major disruption of both domestic and foreign trade, contributed to the rapid rise of the Alibaba Group, an E-Commerce giant in China.[7] A temporary shift in business transactions from offline to online may have triggered a more long-run structural change in economic activities.

3 Data and Identification

We use micro trade data sets from China's Customs Office. It covers monthly export and import transactions of all Chinese firms. For this paper, we use data between 2001 and 2005, which cover the period before and after the SARS epidemic in 2003. For each transaction, the data set contains information about the value (in US dollars) and quantity of each product (over 7000 HS 8-digit categories) exported (imported) to (from) each country (over 200 destination and source countries) by each firm. We also have information on the ownership type (domestic private, foreign, and state-owned) and trade regime (processing versus non-processing) of each trading firm, as well as the province or municipality city in China where the firm trades. We aggregate the data to the HS

[6] "The Trade Show of Everything' *The Atlantic* MAY 23, 2016. (Source: https://www.theatlantic.com/business/archive/2016/05/canton-fair-guangzhou-everything/483545/)

[7] "The SARS epidemic threatened Alibaba's survival in 2003—here's how it made it through to become a $470 billion company" CNBC March 26, 2020. (Source: https://www.cnbc.com/2020/03/26/chinas-2002-2003-sars-outbreak-helped-alibaba-become-e-commerce-giant.html)

6-digit product level. To average out noise due to infrequent trade and seasonality (e.g., the factory shutdown during the Lunar New Year can happen in January or February depending on the year), we aggregate the monthly observations to the quarterly level. See Table A1 in the appendix for the summary statistics of the variables of interest used in the regressions.

To identify the effects of the epidemic on firms' trade patterns, we exploit the timing of the outbreak of local transmission of SARS across Chinese regions (provinces or municipality cities) as quasi-natural experiments. As discussed, the announcement by the WHO about which region in China had a local outbreak varies across time, giving us both spatial and time variation in the shocks to firms. Table A2 in the appendix lists the start and end quarters for the regions that had a SARS outbreak in 2002-2003. 8 provinces and 2 municipality cities (Beijing and Tianjin) had local outbreaks during the epidemic. Guangdong was the first region that experienced the outbreak in the fourth quarter of 2002, followed by Beijing, Inner Mongolia and Shanxi which had an outbreak in the first quarter of 2003. The remaining regions had their outbreak started in the second quarter of 2003. All regions had the epidemic ended in the third quarter of 2003, according to the WHO.

We exploit the nature of the shocks to obtain difference-in-differences estimates across time and regions. Firms in the affected regions during the SARS epidemic belong to the treatment group, while those from regions that never had a local outbreak belong to the control group. In our empirical specifications, the treatment variable, $SARS_{rt}$, takes the value 1 from the quarter (t) (inclusive) when region r reported the first local transmission of SARS until the end of the epidemic (i.e., the third quarter of 2003), and zero otherwise.[8]

We first examine the impact of SARS on firms' exports and imports by estimating the following specification at the firm level:

$$\Delta \ln X_{frt} = \beta_1 SARS_{rt} + \delta \ln X_{fr,t-1} + d_t + \epsilon_{frt}. \tag{1}$$

The dependent variable is the change in firm f's log quarterly (t) trade (export or import) value from the same quarter in the previous year ($\ln X_{frt} - \ln X_{frt-4}$). Since the SARS epidemic was active in China during the first three quarters of 2003, we use data for the first three quarters of both 2002 and 2003. Year-to-year changes for each quarter in 2001-2002 correspond to the pre-treatment

[8] Source: https://www.who.int/csr/sars/areas/areas2003_11_21/en/

period, while those in 2002-2003 correspond to the treatment period for the affected firms. We also use as dependent variables the number of products exported (imported), number of destination (origin) countries and the dummy for exit from exporting (importing). Time (year-quarter) fixed effects (d_t) are always included to take aggregate shocks into account, as well as the firms' (log) lagged quarterly trade value ($\ln X_{fr,t-1}$, exports or imports). Since the equation is estimated in differences, unobserved firm-specific characteristics are already absorbed. The coefficient β_1 identifies the differential effect of SARS on trade for firms in the affected regions, relative to the pre-SARS period and to firms in the unaffected regions. This allows us to infer whether the epidemic contributes to a differential loss in trade growth, controlling for prior trends. ϵ_{frt} is a disturbance term. Standard errors are clustered by firm. We will also estimate a variant of (1) by using as a dependent variable the dummy indicating whether a firm exits from trade (exporting or importing) in quarter t.

To study which firms or products were more vulnerable to the SARS shock, we estimate the following specification at a more disaggregated level:

$$\Delta \ln X_{frsct} = \gamma_1 SARS_{rt} + \gamma_2 (SARS_{rt} \times Z_{fs}) + \gamma_3 Z_{frs} + \alpha \ln X_{fr,t-1} + d_t + \epsilon_{frsct}. \qquad (2)$$

Here, the dependent variable, $\Delta \ln X_{fsrt}$, is the change in the log export (import) value of firm f (in province r), for product s, to (or from) country c, relative to the same quarter in the previous year ($\ln X_{frsct} - \ln X_{frsct-4}$). Estimation is therefore based on continuing triplets (i.e., a firm continued to trade in a country-product market). Time fixed effects and (log) firm lagged quarterly exports ($\ln X_{fr,t-1}$) are always included. Since the equation is estimated in differences, it accounts for unobserved characteristics at the firm-product-country level. Standard errors are clustered by firm. ϵ_{frsct} is a disturbance term. Z_{frs} is a vector of firm and product characteristics to explain the trade decline and the eventual recovery. These characteristics are measured based on the data in 2002, prior to SARS, to avoid changes induced by SARS that will bias the estimates. The coefficient γ_2 captures the differential changes induced by SARS according to those characteristics.

To study the recovery period after the SARS epidemic was announced to be over by the WHO in the third quarter of 2003, we estimate a specification similar to equation (2) but for growth in every quarter in 2004 and 2005 (relative to the previous year) as the post-SARS period, compared

to their corresponding growth in the four quarters in 2002 (relative to 2001). In that specification the SARS dummy takes the value 1 for regions that had a SARS outbreak in all quarters of 2004 and 2005 and zero for 2002 and for the unaffected firms. The estimated coefficients will inform us about the potential medium-term effects of SARS on firms' trade growth, and whether there is any heterogeneity.

4 Results

4.1 Trade Performance During SARS

We start by providing a graphical illustration of the differential export and import growth in the affected (the treatment group) regions, relative to the unaffected regions (the control group), before and after the SARS outbreak. Figure 1 plots the dynamic treatments from three quarters before the outbreak in a region ($t = -3$ in the graph) to the last quarter in 2005 ($t = 12$). $t = 0$ is the reference quarter when a Chinese region started to have its local transmission of SARS.[9] Specifically, it plots the point estimates from estimating a slightly adjusted version of specification (2), where the dependent variable is still the log difference in export (import) values at the firm-product-country level from the same quarter a year ago, but the independent variables of interest are a set of quarter indicators that take the value 1 for the affected firms, in each lead and lag quarter from the SARS shock, relative to the start of the SARS outbreak in a region, and zero otherwise, allowing estimation of a time-varying effect of the disruption. The regressions control for the pre-trend by including a post-2003 dummy. The vertical bars around each point estimate show the 95 percent confidence intervals.

The figure shows a short dip during the SARS quarters, and then a rapid recovery right after the end of the epidemic, which gradually dissipated into the negative territory by the end of 2004, about a year after SARS ended. In particular, the coefficients for the exposed firms' import and export growth are both positive in the 2 lead quarters prior to the outbreak. There is also no negative trend for the affected firms. If anything, the growth rate of imports for the firms in the affected regions was actually increasing in the 3 quarters leading to the outbreak. These results collectively

[9] As mentioned above, different regions had their $t = 0$ in different quarters. It is the first quarter of 2002 for Guangdong and the first or second quarter of 2003 for other regions.

suggest no pre-trend among the treated firms. The coefficients become negative and statistically significant for the firms in the affected regions after the epidemic began, and both of their export and import growth remained lower than those of the unaffected firms' in the three quarters since the outbreak started. Specifically, during the epidemic, firms in the affected regions experienced a -1.4 percentage-point relative decline in annualized growth in both exports and imports for three consecutive quarters.

Firms in the affected regions, conditional on survival, experienced a significant recovery starting from the quarter right after SARS ended. Firms' annualized growth was higher for exports in 5 consecutive quarters and for imports in 4 consecutive quarters among the affected firms from the quarter right after the epidemic ended ($t = 4$). This finding of a rebound may be specific to the short duration of the epidemic, when the WHO officially announced in the third quarter of 2003 that the epidemic was under control globally. As shown in Table A2 in the appendix, the epidemic lasted for less than 2 quarters in 6 out of 10 affected regions.

Despite the immediate and sharp trade recovery, the rebound ended in about a year. The affected firms' export growth was lower in the last 3 quarters in 2005 than the unaffected counterparts, while their import growth was lower since the last quarter of 2014 to the end of 2015. In particular, in the last quarter of 2015, the affected firms had a 4 and 6 percentage-point lower export and import growth, respectively, relative to the unaffected firms. This shows that SARS had a medium-term effect on Chinese trade, in contrast to the conventional view.

Table 1 reports the estimates of equation (1). We estimate the regressions separately for firms' exports and imports. In Panel A, we find that controlling for time fixed effects and firms' lagged total export values, firms in the regions (provinces and municipality cities) that had a SARS outbreak in 2002-2003 had a roughly 11 percentage-point lower export growth on average relative to the pre-SARS period and to the non-exposed firms (column 1). The difference-in-differences estimates account for potential differences in growth trends between the treated and the non-treated firms before the SARS outbreak. Columns (2) and (3) of Table 1 show that the SARS epidemic also contributed to an average 4 percentage-point lower growth in the number of exported products and destination markets respectively among the exposed firms.

In the last column, we gauge the impact of the SARS outbreak on the likelihood of firms' exit

from exporting.[10] Exploiting the firms' quarterly export data, we find that firms in the affected regions have about 0.6 percentage-point higher probability of exit from exporting during the SARS outbreak, relative to the unaffected firms and the pre-SARS period.

In Panel B of Table 1, we find consistent results that firms in the affected regions experience a larger decline in imports, at both the intensive and extensive margins. Specifically, firms in the regions that had an outbreak experienced a roughly 6 percentage-point lower import growth relative to the pre-SARS period (2001-2002) and to the non-exposed firms. Firms in the affected regions tend to drop products and source countries, relative to those that did not experience an outbreak. The affected importers have an 8 percentage-point *lower* probability of exit from importing, implying that when domestic supply was disrupted, consumers and firms might have switched input sources from domestic to foreign suppliers.

As the first analysis of the heterogeneous effects of SARS on firms' trade outcomes, in Panels C and D of Table 1, we show the estimates of (2) with the dummy for exit from exporting (or importing) as the dependent variable. In column (1), we add as a regressor an interaction term between the SARS dummy and a dummy that takes the value 1 if the firm's export (import) volume is above the median of the firms' main industry (defined as the HS2), and zero otherwise. We find that larger firms are less likely to exit from exporting, consistent with the conventional wisdom that larger firms are more capitalized and thus less budget-constrained. We also find that foreign and processing exporters (if processing exports account for over 50% of the firms' exports) are less likely to exit from exporting. To the extent that many processing firms are foreign-invested enterprises, which tend to have access to internal capital markets in foreign countries (Manova, Wei, and Zhang, 2015), their lower likelihood of exiting from trade is expected. We also find that state-owned enterprises (SOEs) are more likely to exit. While SOEs are generally expected to have soft budget constraints (Qian and Roland, 1998), the Chinese government intended to use trade liberalization to foster privatization in the early 2000s (Khandelwal, Schott, and Wei, 2013; Hsieh and Song, 2015). It is therefore possible that during the SARS epidemic, the Chinese governments did not provide extra support to SOEs to survive exporting.

We repeat the same analysis on firms' exits from importing, and find that despite a relatively

[10] A firm's trade (import or export) exit dummy is set to 1 if a firm traded for the last time in the current quarter, and is zero in all previous quarters.

lower probability of firms' exits (or higher probability of survival) from importing, larger, processing, and state-owned firms are relatively more likely to exit from importing, while foreign firms are more likely to continue to import. These results are largely consistent with the results about the extensive margins on the export side.

In Table 2, we examine the potential heterogeneous effects of the epidemic on firms' intensive margin of import and export growth, depending on firm characteristics. To this end, we estimate equation (2) at the firm-product-country level. In column (1), we estimate the average treatment effect across firms; the difference-in-differences coefficient implies that the exposed firms (those in the affected regions) experience a roughly 3 percentage-point lower average export growth across markets (country-product pairs) during the outbreak period, relative to the pre-SARS period and to the non-exposed firms. In the subsequent columns, we estimate the triple difference effects according to firm characteristics. In column (2) we interact the $SARS_{rt}$ variable with the dummy variable for whether the firm is above the median size across firms in the same industry (the HS2 of the firms' main line of business). We find that larger firms had a significantly bigger decline in exports. Together with the evidence that smaller firms are more likely to exit, our findings suggest that the shock induces smaller firms to exit, while larger firms tended to survive by adjusting their export growth instead.

In columns (3) and (4) we find that processing exporters in the affected regions experienced a relatively larger drop in export growth, while foreign firms appeared to be more resilient and had a smaller decline in export growth. Column (5) shows that SOEs experienced a significantly larger decline in export growth. All these results are consistent with our earlier explanations for the patterns of the adjustments on the extensive margin.

In the lower panel of Table 2, we report similar results for imports. Specifically, we find that surviving importers in the affected regions experienced a slower annualized import growth, and larger firms, processing exporters, and SOEs all experienced an even larger decline, relative to those in the unaffected regions. The fact that larger and processing firms experience a relatively slower import growth in the affected regions are consistent with the trend during the sample period, as documented by Kee and Tang (2016), that Chinese exporters in general become less dependent on foreign inputs. Those that had their global supply disrupted for a short period of time may have decided to either reorient input sources from foreign to domestic suppliers. Foreign firms, once

again, seemed to be more resilient to the epidemic shocks, in terms of maintaining a solid import growth (column (4)).

Table 3 reports the estimates of (2) by exploring the potential heterogeneous effects of the epidemic on firms' intensive margin of import and export growth, according to product characteristics. In column (1), we interact the $SARS_{rt}$ treatment variable with an indicator variable that takes the value of 1 if the import demand elasticity, provided by Broda and Weistein (2006), is above the median across HS3-digit tariff.[11] We find that goods that are more substitutable experienced a larger fall in exports. In particular, the export growth of the high-elasticity goods drop by an additional 2 percentage-points on average during the epidemic. These results are consistent with Furusawa et al. (2018), who find that sourcing of differentiated inputs are less vulnerable to external shocks on trade.

In columns (2)-(4), we examine the potential differential effects between intermediate inputs and final goods, as well as those between consumption goods and capital goods.[12] As is shown, the export growth of consumption goods is more negatively affected by SARS, while capital goods were less negatively impacted. Intermediate inputs did not exhibit a different response to the outbreak, compared to final goods. In column (5), we find that products that are produced in the relatively more upstream position in the global supply chains, as defined by the upstreamness index proposed by Antras et al. (2012), were less negatively affected by the epidemic.[13] In other words, goods that are closer to the consumers, which tend to be more substitutable by goods from other countries, were more negatively affected by the epidemic. In the last two columns, we find that capital- and skill-intensive goods are also less affected by SARS.[14] In sum, the heterogeneous effects across products we document reveal that less substitutable and more sophisticated products are naturally more resilient to the supply shocks caused by an epidemic.

In the lower panel of Table 3, we repeat the same empirical exercises for annualized import growth for each quarter in 2002-2003. We find that firms' imports of the more substitutable goods

[11] We use Broda and Weistein (2006) import demand elasticity for the US for the exports regressions and for China for imports regressions.

[12] We use the UN-BEC classification to classify each HS6 product as an input, consumer good, or capital good.

[13] Specifically, we add as a regressor an interaction term between the SARS dummy and a dummy that takes the value 1 if the firm's main industry (HS2) upstreamness index is above the median of all HS2 categories.

[14] Specifically, we add as a regressor an interaction term between the SARS dummy and a dummy that takes the value 1 if the firm's main product (HS6) capital or skill intensity measure, provided by Ma et al. (2014), is above the median of all HS6 categories.

(column (1)) are relatively more affected by the epidemic. These results are consistent with our expectation, based on the findings that more substitutable exports experienced a more significant growth slowdown. We also find, as reported in columns (2) and (3), that imports of intermediate inputs and goods produced in upstream sectors experienced a sharper decline in import growth. While these findings seem to contrast with their relatively more resilient export performance, they are consistent with the notion that imports of inputs will be first affected, when reduced export demand in the months ahead is anticipated.

4.2 Trade Performance After SARS

In the rest of the paper, we will document some new facts about the recovery of Chinese trade after the SARS epidemic. To this end, we estimate specification (2), but using the panel of 2004-2005 (relative to the previous year) as the post-SARS period, compared to their corresponding growth in the four quarters in 2002 (relative to 2001). In that specification, the SARS dummy takes the value 1 for regions that had a SARS outbreak in all quarters of 2004 and 2005 and zero for 2002 and for the unaffected firms.

Before reporting any heterogeneous effects, in column (1), we show that firms' export growth remained lower than the pre-trend (2001-2002), relative to the unaffected firms. Specifically, the average annualized export growth across the 8 quarters in 2004-2005 is on average around 3 percentage-point lower than that of the unaffected firms and the pre-trend. Column (2) shows that the slower growth was largely driven by larger firms having slower growth compared to smaller firms after the pandemic. Together with the above finding that small and medium enterprises were more likely to exit during SARS, the fact that exports grow slower in the affected regions in the medium run may be related to the reallocation of resources from small to large firms. We also find that processing firms' exports (column (4)) tend to grow even slower during the recovery period in the affected regions in post-SARS China.

In Panel B, we report no difference in average import growth between the exposed and unexposed firms. That said, large firms (column (2)), processing exporters (column (4)), and SOEs (column (6)) tend to experience slower import growth in the affected regions, while foreign firms tended to have faster import growth (column (5)).

We next show the estimates of (2) to examine whether firms' import and export recovery

vary across different types of products. As shown in Panel C, we find that export growth of the highly substitutable products (column (1)) and consumption goods (column (3)) respectively remained significantly lower for firms in the affected regions in the post-SARS period. Exports of intermediate (column 2), more upstream (column 5), capital-intensive (column 6), and skill-intensive goods (column 7) all experience a relatively more robust recovery. These findings are consistent with the hypothesis that widely available substitutes in foreign countries, including mass-produced consumption goods and downstream low-tech products, could have replaced some Chinese exports permanently, despite a temporary disruption of trade.

Finally, we repeat the same set of regressions for import recovery. As reported in Panel D of Table 4, despite no significant relationship between firms' import recovery and the SARS outbreak, we find that the affected firms experienced a lower recovery than the unaffected firms for the highly substitutable products (column 1) and consumption goods (column 3), consistent with our earlier findings that the more substitutable exports experienced a sharper decline and a slower recovery.

5 Concluding Remarks

This paper studies the impact of the SARS epidemic on China's trade in 2003-2005. Based on the quarterly transaction-level trade data of all Chinese firms, we find that firms in regions with local transmission of SARS experience lower import and export growth at both the intensive and extensive margins, compared to those without. The affected firms' trade growth remains significantly lower 2 years after the end of SARS. Products that are more capital-intensive, skill-intensive, upstream in the supply chains, and differentiated experienced a smaller decline in exports but a stronger recovery. Small exporters are more likely to exit. The surviving large firms, which tended to grow slower, dragged down the affected regions' export recovery.

With China's moving up the value chains and a more global and uncertain nature of Covid-19, the outcomes this time may well be different. China is now less dependent on processing exports and more specialized in skill- and capital-intensive products. It commands a lot more in the upstream of the various sophisticated supply chains. The good news, according to our research, is that China may experience a smaller decline in exports due to the pandemic, all else equal, as foreign buyers may not be able to find substitutes easily. The bad news is that the low substitutability of Chinese

products implies a larger disruption of the supply chains. The increased interconnections between firms and countries in global production sharing since 2003 also implies that the propagation of demand or supply shocks will tend to have larger effects on other connected firms and economies.

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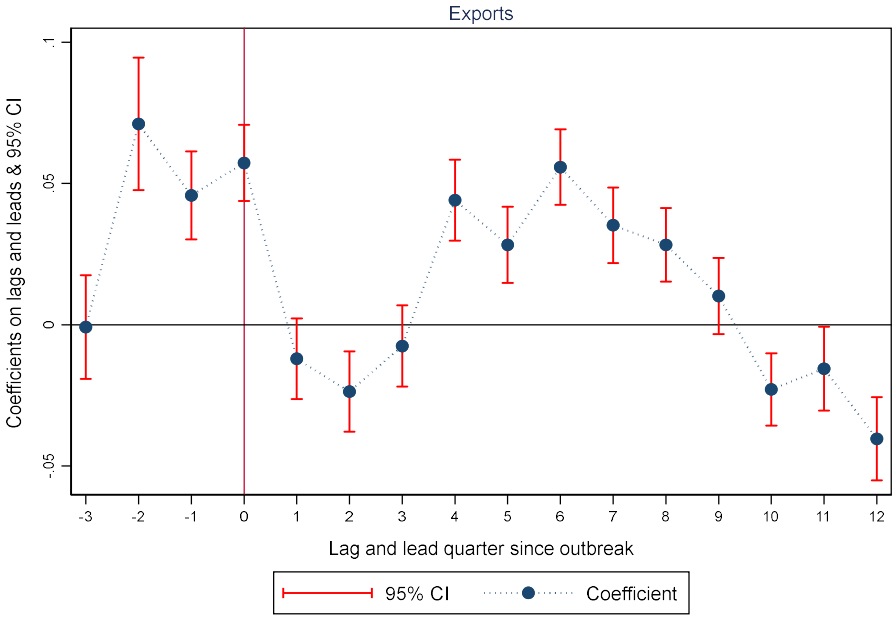

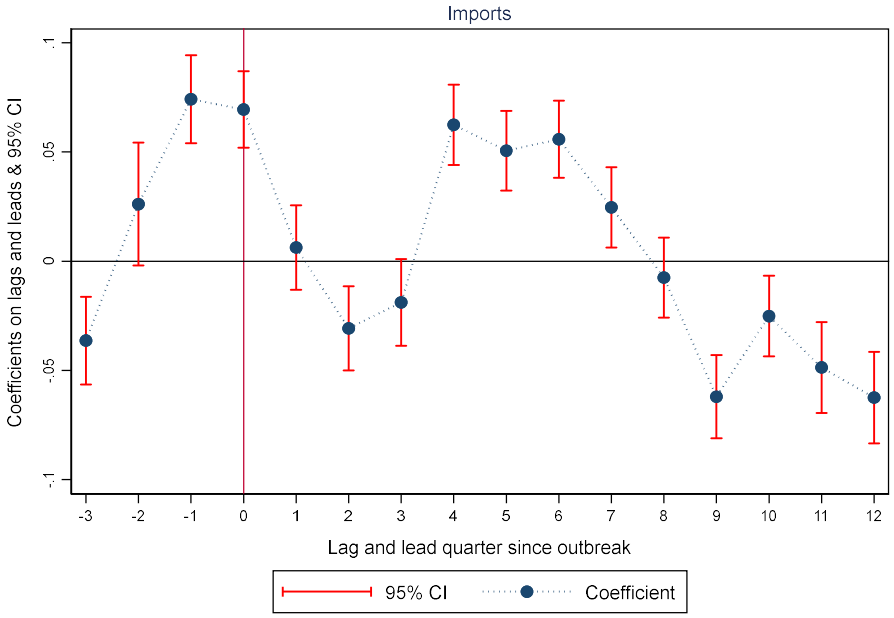

Figure 1: Dynamic treatments over time, quarterly 2002-2005

The Figure shows point estimates from a difference-in-differences regression where the dependent variable is the log difference in export (import) values from the same quarter a year ago, at the firm-product-country level. The independent variables of interest are a set of quarter indicators that take the value 1 for the firms in the regions that had an outbreak, according to the World Health Organization, in each lead and lag quarter from the first quarter (t=0) of the SARS epidemic, and zero otherwise. Regressions control for pretrend by including a post-2003 (inclusive) fixed effect. Vertical bars show 95 percent confidence intervals.

Table 1: Firm-level Export and Import growth, 2002-2003

	(1)	(2)	(3)	(4)
	Panel A: Export Performance			
Dependent variable:	△ln(volume)	△ln(no. hs6)	△ln(no. countries)	Exit
SARS	-0.112***	-0.0376***	-0.0384***	0.00573***
	(0.00815)	(0.00408)	(0.00400)	(0.00118)
N	279255	279255	279255	400227
R2	.11	.017	.0216	.00698
	Panel B: Import Performance			
Dependent variable:	△ln(volume)	△ln(no. hs6)	△ln(no. countries)	Exit
SARS	-0.0573***	-0.0612***	-0.0226***	-0.0809***
	(0.0111)	(0.00558)	(0.00415)	(0.00160)
N	220578	220578	220578	336713
R2	.115	.0272	.0164	.0232
	Panel C: Exit from Exporting			
Dependent variable:	Exit Dummy			
Firm characteristic (Z):	size	EP firm	foreign	SOEs
SARS	0.00840***	0.0162***	0.0792***	0.00397***
	(0.00187)	(0.00182)	(0.00338)	(0.00119)
SARS*dz	-0.00926***	-0.0161***	-0.0847***	0.0640***
	(0.00204)	(0.00210)	(0.00350)	(0.00609)
N	400227	400227	400227	400227
R2	.0331	.00513	.0126	.00826
	Panel D: Exit from Importing			
Dependent variable:	Exit Dummy			
Firm characteristic (Z):	size	EP firm	foreign	SOEs
SARS	-0.0987***	-0.0349***	-0.00980*	-0.0873***
	(0.00273)	(0.00298)	(0.00556)	(0.00164)
SARS*dz	0.0472***	0.0107***	-0.0682***	0.0809***
	(0.00284)	(0.00317)	(0.00567)	(0.00775)
The Figure shows point	220578	220578	220578	220578
R2	.0283	.0275	.0277	.0277

Observations are by firm-quarter. Data are for each of the first three quarters of 2002 and 2003. In Panel A and B, dependent variables in the first 3 columns are the log difference in the variable of interest from the same quarter a year ago. SARS takes the value 1 for region (provinces or municipality cities) with local transmission of SARS since its outbreak, and zero otherwise. Changes between 2002-2001 correspond to the pre-treatment period, and between 2003-2002 to the treatment period after a SARS outbreak was announced by the WHO. Time fixed effects are always included as controls. Lagged quarterly firm exports (imports) are always included in columns (1)-(3) of Panels A and B. In Panels C and D, dZ is a dummy variable that takes the value 1 if the firm is above the median size across firms in an industry (HS2) in column (1); if the firms' processing exports (imports) account for over 50% in column (2); or if the a firm is foreign or a SOE in the remaining columns, respectively, and zero otherwise. The dZ terms are always included, but they are not reported for space consideration. Standard errors clustered by firm are reported in parenthesis. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 2: Firm-product Export and Import Growth and Firm Characteristics, 2002-2003

	(1)	(2)	(3)	(4)	(5)
Firm characteristic (Z):		size	EP firm	foreign	SOEs
Dependent variable:		export growth: $\triangle \ln(X_{fcp})$			
SARS	-0.0274***	0.106***	-0.00578	-0.0533***	-0.0266***
	(0.00721)	(0.0121)	(0.0130)	(0.0160)	(0.00694)
SARS*dz		-0.149***	-0.0438***	0.0291*	-0.0746***
		(0.0126)	(0.0169)	(0.0170)	(0.0235)
N	1899930	1899930	1899930	1899930	1899930
R2	.00216	.0029	.0022	.00217	.00223
Dependent variable:		import growth: $\triangle \ln(M_{fcp})$			
SARS	-0.0543***	0.0987***	0.0865***	-0.105***	-0.0429***
	(0.0104)	(0.0183)	(0.0184)	(0.0211)	(0.0115)
SARS*dz		-0.170***	-0.134***	0.0647***	-0.0847***
		(0.0183)	(0.0190)	(0.0233)	(0.0266)
N	1721900	1721900	1721900	1721900	1721900
R2	.00199	.00297	.00311	.00203	.00203

Observations are by firm-product(HS6)-country-quarter. Data are for each of the first three quarters of 2002 and 2003. Dependent variables are the log difference in the variable of interest from the same quarter a year ago. Changes between 2002-2001 correspond to the pre-treatment period, and between 2003-2002 to the treatment period, after the SARS outbreak began in the affected regions. dZ is a dummy variable that takes the value 1 if the firm is above the median size across firms in an industry (HS2) in column (1); if the firms' processing exports (imports) account for over 50% in column (2); if the firm is a foreign or a SOE in columns (3)-(4), respectively; and zero otherwise. Time fixed effects and lagged quarterly firm exports (imports) are always included. The dZ terms, when the corresponding interaction terms are added, are always included. They are not reported for space consideration. Standard errors clustered by firm in parenthesis. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 3: Firm-product-country level Export and Import Growth and Product Characteristics, 2002-2003

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Product characteristic (Z):	high elasticity	input	cons. goods	capital goods	upstreamness	capital int.	skill int.
Dependent variable:				export growth: $\triangle \ln(X_{fcp})$			
SARS	-0.0187**	-0.0284***	-0.0165**	-0.0337***	-0.0522***	-0.111***	0.0172
	(0.00798)	(0.00784)	(0.00809)	(0.00751)	(0.0147)	(0.0291)	(0.0131)
SARS*dZ	-0.0208**	0.00655	-0.0224**	0.0565***	0.0136**	0.0200***	0.0510***
	(0.00925)	(0.00950)	(0.00957)	(0.0138)	(0.00683)	(0.00655)	(0.0135)
N	1866556	1899930	1899930	1899930	1899199	1883799	1880414
R2	.00229	.00222	.00231	.00224	.00218	.00245	.00252
Dependent variable:				import growth: $\triangle \ln(M_{fcp})$			
SARS	-0.0299**	-0.0226	-0.0555***	-0.0547***	0.00800	-0.0582	-0.0483***
	(0.0131)	(0.0146)	(0.0104)	(0.0102)	(0.0262)	(0.0363)	(0.0136)
SARS*dZ	-0.0406***	-0.0403***	0.00662	0.00923	-0.0256***	0.000187	0.0175
	(0.00985)	(0.0105)	(0.0154)	(0.0165)	(0.00850)	(0.00666)	(0.0135)
N	1713047	1721900	1721900	1721900	1721855	1702030	1687630
R2	.00205	.00201	.00203	.00201	.002	.00225	.00261

Observations are by firm-product(HS6)-country-quarter. Data are for each of the first three quarters of 2002 and 2003. Dependent variables are the log difference in the variable of interest from the same quarter a year ago. Changes between 2002-2001 correspond to the pre-treatment period, and between 2003-2002 to the treatment period, during SARS. dZ is a dummy variable that takes the value 1 if the import demand elasticity, provided by Broda and Weistein (2006), for the US for exports and for China for imports, is above the median across HS3-digit categories in column (1), or if the HS6-digit product is an input, consumer good, or capital good in columns (2)-(4), respectively, according to the UN BEC list; or if the upstreamness index, provided by Antras et al. (2012), is above the median across HS2-digit categories in column (5); or if the capital and skill intensity, provided by Ma et al. (2014), is above the median across HS6-digit categories in columns (6) and (7), and zero otherwise. Time fixed effects and lagged quarterly firm exports (imports) are always included. The dZ terms are always included. They are not reported for space consideration. Standard errors clustered by firm in parenthesis. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 4: Firm-product-country level Export and Import Growth and Firm Characteristics, 2004-2005, compared to 2002

Panel A: Dependent Variable = export growth: $\triangle\ln(X_{fcp})$						
	(1)	(2)	(3)	(4)	(5)	(6)
Firm characteristic (z):	-	size	new	EP firm	foreign	SOEs
SARS	-0.0278***	0.0502***	-0.0276***	0.00609	-0.0304**	-0.0337***
	(0.00521)	(0.00841)	(0.00521)	(0.00799)	(0.0123)	(0.00516)
SARS*dz		-0.0871***	0.0166	-0.0483***	-0.00131	-0.00873
		(0.00934)	(0.0138)	(0.0102)	(0.0130)	(0.0197)
Panel B: Dependent Variable = import growth: $\triangle\ln(M_{fcp})$						
SARS	-0.00426	0.0986***	-0.00223	0.0535***	-0.0551***	0.00806
	(0.00748)	(0.0123)	(0.00799)	(0.0105)	(0.0175)	(0.00752)
SARS*dz		-0.114***	-0.000446	-0.0452***	0.0645***	-0.0849***
		(0.0135)	(0.0174)	(0.0126)	(0.0184)	(0.0209)

Panel C: Dependent variable = export growth: $\triangle\ln(X_{fcp})$							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Product characteristic (Z):	high elasticity	input	cons. goods	capital goods	upstreamness	capital int.	skill int.
SARS	-0.0194***	-0.0351***	-0.0178***	-0.0293***	-0.0675***	-0.109***	0.0301**
	(0.00607)	(0.00605)	(0.00584)	(0.00528)	(0.0105)	(0.0228)	(0.0146)
SARS*dZ	-0.0188***	0.0239***	-0.0248***	0.0102	0.0236***	0.0198***	0.0223***
	(0.00633)	(0.00677)	(0.00680)	(0.0114)	(0.00448)	(0.00501)	(0.00591)
Panel D: Dependent variable = import growth: $\triangle\ln(M_{fcp})$							
SARS	0.00821	0.00140	-0.00176	-0.00559	-0.00306	-0.0848***	0.0142
	(0.00964)	(0.0110)	(0.00749)	(0.00726)	(0.0175)	(0.0241)	(0.00929)
SARS*dZ	-0.0220***	-0.00711	-0.0492***	0.0147	-0.00130	0.0152***	0.0421***
	(0.00705)	(0.00751)	(0.0117)	(0.0102)	(0.00558)	(0.00443)	(0.00898)

Observations are by firm-product(HS6)-country-quarter. Data are for all quarters of 2002 and 2004-2005. Dependent variables are the log difference in the variable of interest from the same quarter a year ago. SARS takes the value 1 for all quarters of 2004 and 2005 for the firms in regions that are affected by SARS (in 2002-2003), and zero otherwise. Changes for 2004-2005 correspond to the post-epidemic period, and for 2002 to the pre-epidemic period. In Panels A and B, dZ is a dummy variable that takes the value 1 if the firm is above the median size across firms in an industry (HS2) in column (1); if the firms' processing exports (imports) account for over 50% in column (2); if the firm is a foreign or a SOE in columns (3)-(4), respectively; and zero otherwise. In Panels C and D, dZ is a dummy variable that takes the value 1 if the import demand elasticity, provided by Broda and Weistein (2006), for the US for exports and for China for imports, is above the median across HS3-digit categories in column (1), or if the HS6-digit product is an input, consumer good, or capital good in columns (2)-(4), respectively, according to the UN BEC list; or if the upstreamness index, provided by Antras et al. (2012), is above the median across HS2-digit categories in column (5); or if the capital and skill intensity, provided by Ma et al. (2014), is above the median across HS6-digit categories in columns (6) and (7), and zero otherwise. In all specifications, time fixed effects and lagged quarterly firm exports (imports) are always included. The dZ terms are always included in when its interaction terms are included. They are not reported for space consideration. Standard errors clustered by firm in parenthesis. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table A1: Summary Statistics

	Nb of Obs	Mean	Median	Min	Max
SARS	549,052	0.211	0.408	0	1
Foreign	549,052	0.623	0.485	0	1
SOE	549,052	0.155	0.362	0	1
△ln(volume) [Export]	382,736	0.139	1.310	-14.235	13.704
△ln(no. hs6) [Export]	382,736	0.069	0.665	-6.232	6.217
△ln(no. countries) [Export]	382,736	0.097	0.613	-4.477	4.635
Export Exit Dummy	549,052	0.037	0.188	0.000	1.000
△ln(volume) [Import]	300,229	0.035	1.710	-15.368	13.351
△ln(no. hs6) [Import]	300,229	0.009	0.816	-6.118	5.796
△ln(no. countries) [Import]	300,229	0.040	0.576	-3.689	3.638
Import Exit Dummy	457,722	0.065	0.246	0	1

Source: China's Customs (2001-2003)

Table A2: Areas (provinces and municipality cities) that had local SARS infections

Region	Start Quarter	End Quarter
Beijing	2003q1	2003q3
Guangdong	2002q4	2003q3
Hebei	2003q2	2003q3
Hubei	2003q2	2003q3
Inner Mongolia	2003q1	2003q3
Jilin	2003q2	2003q3
Jiangsu	2003q2	2003q3
Shanxi	2003q1	2003q3
Shaanxi	2003q2	2003q3
Tianjin	2003q2	2003q3

Source: World Health Organization