Trade Under Lockdown *

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Preliminary version

Abstract

The Covid-19 pandemic and the measures of lockdown that have been implemented in many countries in the early months of 2020 have strongly impacted global growth. This paper studies the role of lockdown measures for the evolution of international trade. We use trade data for 18 reporting countries detailed by product and partner, combined with data on the intensity of lockdown for many countries. Lockdown stringency had a strong impact on both exports and imports. Implementing a lockdown of maximum stringency reduces bilateral exports by 24% on average while imports fall by 20%. These results are additive in a bilateral relationship. We then show that the lockdown had heterogeneous effects across sectors, and we study the role of global value chains in the transmission of the recession across borders.

Keywords: COVID-19, lockdown, trade elasticities.

JEL Classification: F14, xxx.

*The opinions expressed are the authors own and do not necessarily reflect the views of the Banque de France or the Eurosystem.

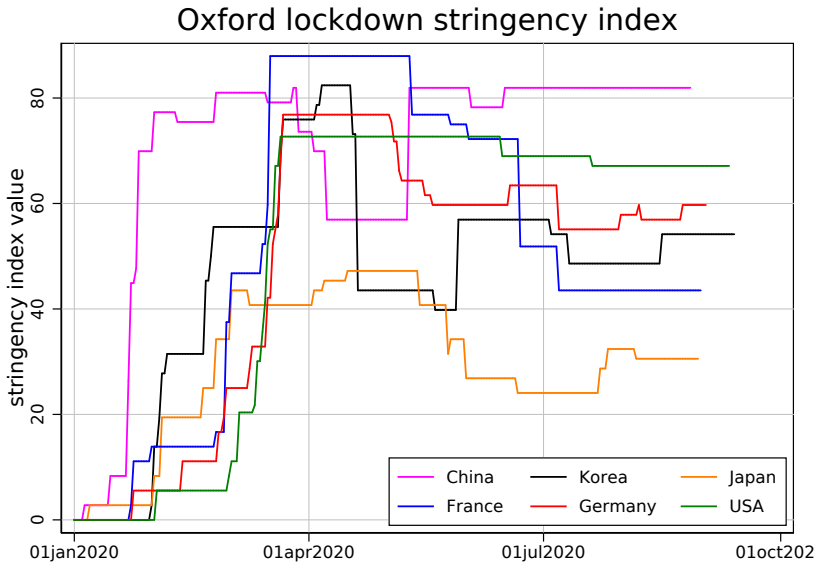
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1 Introduction.

The Covid-19 pandemic triggered a wide range of government responses to limit its spread among the populations. This included closing of schools, workplaces, restaurants etc. as well as restrictions to transportation or to international travel. These restrictions can be illustrated using the composite index compiled by researchers from the University of Oxford (Hale et al., 2020) (see Figure 1). Since January 2020, many governments introduced restrictions along the different aspects of economic and social activity covered through the Oxford Stringency index. However, these restrictions were implemented at different pace and with different intensity, with a peak reached in April 2020 before restrictions were progressively removed. As a second wave of the pandemic may hit, new lockdown measures could be implemented.

Figure 1: Oxford lockdown stringency index by country



Note: composite Oxford Stringency Index, University of Oxford.

The objective of this paper is to document the trade impact of the administrative restrictions / lockdowns implemented in exporting and importing countries. To this aim, we combined the monthly averages of the Oxford stringency index with trade data reported by 18 countries at a monthly frequency, and detailed by partner country and HS6

product.[1]

Our first result is that both exporter and importer lockdown stringency substantially reduced bilateral trade. Implementing a lockdown of maximum stringency reduces bilateral exports by 24% on average while imports fall by 20%, suggesting that lockdowns affected the economy through adverse shocks on both demand and supply. The results on exporting and importing country are additive so that bilateral trade almost halves when both partners go into a full lockdown. We then provide evidence that the effect on trade flows is monotonically increasing in lockdown stringency, and that trade flows fall even for very limited lockdown stringency. We also show that, by and large, tightening and loosening lockdown restrictions have had similar quantitative effects, but in opposite directions.

Looking at the effects of lockdowns at the sectoral level, we find strong heterogeneity of effects. Among the most strongly affected sectors are ships, aircrafts, leather, and vehicle production, while other sectors such as food and chemicals have been virtually unaffected. We do not yet have a good explanation for the causes of this heterogeneity, and this will be one avenue for further work in this project.

We then study the adjustment of trade prices vs quantities to lockdowns. To do so, we analyze the behaviour of HS6 unit values and quantities, using a dataset of over 20 million observations. We find that, consistent with the idea of an adverse supply shock, a lockdown in the exporting country reduces quantities but increases prices. The reaction of quantities is much stronger that that of prices, leading to the fall in values described before. Surprisingly, however, we also find a statistically significant (although quantitatively small) increase in importer prices following an importer lockdown. Finally, future analysis will focus on the role of global value chains in the transmission of the crisis across borders, looking at both forward and backward linkages.

How should these findings be interpreted? A clear challenge to the interpretation of our results is that lockdowns are themselves endogenous events, and are chosen as a function of the current or predicted evolution of the pandemic. For instance, Antràs et al. (2020)

[1]The 18 countries are listed in Table 7. We chose these 18 reporters for mainly two reasons: (1) they are representative of a group of both advanced and emerging economies; and (2) they report detailed trade values and quantities by products early on, which allows us to trade the trade impacts of the lockdown(s) on very recent trade patters. For each reporting country and product, the dataset details export and import relations by month with up to 252 partner countries. The results published in this paper will be updated frequently upon new data release.

develop a model of trade and epidemics by combining ingredients from the micro-founded gravity equation in trade with a Susceptible-Infected-Recovered (SIR) model. In the most comprehensive version of the model, agents' behavior endogenously reacts to the threat of infection, which both flattens the epidemic curve but also impacts trade shares with relatively unhealthy countries. in the context of our empirical investigation, it is possible, therefore, that our results do not show the effect of lockdowns themselves, but that trade flows were instead driven by a direct effect of the evolution of the pandemic on the behaviour of firms and consumers. In that case, trade flows would have fallen even in the absence of a lockdown. While we cannot rule out this possibility, we think that our estimates are very suggestive of a causal effect of lockdowns on trade flows. One piece of evidence in favor of a causal interpretation is that consumer expenditure fell sharply only in the days after the introduction of a lockdown, while the pandemic was already gradually evolving before (Carvalho et al., 2020).

This research completes and was inspired by existing work analyzing the effects of restrictions implemented in many countries on economic activity. Guerrieri et al. (2020) in particular interrogate on the transmission of the Covid-19 shock on the economy via supply and demand-side channels. The Covid-19 impact on global trade is transmitted via different channels: (i) the foreign demand for home produced final goods and intermediate inputs originating directly from trade partners or indirectly from third countries (forward linkages); (ii) foreign input production in trade partners or third countries (backward linkages) (Baldwin and Freeman, 2020a). Accounting for third country effects (indirect linkages) appears also important to show the importance of China as a global supplier of intermediate inputs, while global input output tables also clearly show that supply chains are also highly built on a regional basis (Baldwin and Freeman, 2020b).

Calibrated macroeconomic models with input-output linkages allow to investigate the transmission of the pandemic shock through global value chains (Barrot et al., 2020; Gerschel et al., 2020; Lisack et al., 2020; Bonadio et al., 2020). These models generally simulate a reduction in the supply of labor, which heterogeneously distributed across sectors due to the possibility of tele-working. (Barrot et al., 2020) conduct their analysis on France and other European countries with a quantitative model calibrated for 54 sectors, and show that a general lockdown has sizeable negative impact on GDP, in particular in more upstream sectors. Bonadio et al. (2020) calibrate their model for 64 countries and 33 sectors using the OECD Inter-Country Input-Output tables (ICIO).

While most of the GDP impact of lockdown is due to domestic lockdown, about a quarter of the total impact comes from foreign shocks. Importantly, re-shoring value chains in the home economy would not lead necessarily to a decline in the GDP impact of the shock, as these value chains would be less diversified and more exposed to the home economy's lockdown. We contribute to this literature by providing – using trade data available for the period of the Covid-19 crisis for many countries and products – empirical evidence of the role of backward and forward linkages in the transmission of lockdowns across countries.

Meier and Pinto (2020)

The paper is organized as follows. We first describe the data for trade and lockdown stringency. We then present descriptive evidence of the effects of the lockdown stringency on trade. The third section describes the empirical methodology and the econometric model. The fourth section presents the estimation results. The last section concludes.

2 Data and descriptive evidence.

2.1 Data sources.

The analysis is based mainly on two data sources. The first source of data is he Oxford Stringency index, compiled by the University of Oxford (Hale et al., 2020) and updated on a daily basis. In the main analysis and baseline estimations, we used the composite stringency index, which reflects restrictions along different dimensions of the economic and social activity of countries, stemming from school or workplace closing, shops and restaurants, to restrictions on public transportation and international travels. We also complete the analysis based on detailed information on sub-components of this indicator.

The second dataset that we use is the detailed export and import information by country pair ("dyad"), product (initially HS 6-digits) and month compiled from national sources by the Trade Data Monitor. The main advantage of this data, compared with other sources regularly used for research such as Comtrade or BACI, is that it allows frequent updates based on early release by individual countries. From this dataset, given its huge size at this level of disaggregation, we downloaded monthly / bilateral data on exports on imports for 18 reporting countries and up to 252 partner countries. In the early stage

of the analysis, we aggregated this data into HS2 sectors (about 100 of them), but used the HS6 dimension in order to match the data with Broad Economic Categories (United Nations), which is then useful to identify separate impacts for intermediate goods, capital goods and final goods.

2.2 Descriptive evidence.

We provide in this section descriptive statistics on the evolution of aggregate exports and imports for selected countries from our final dataset, between 2019 and 2020. This data reported in figure 2 indicate that the aggregate trade collapse was very synchronized between large advanced economies such as the United States, France and Germany, though the collapse seemed more pronounced for France for both exports and imports. The trade recovery then started in May 2020 when countries started to progressively remove some of the lockdown measures in place at the height of the crisis.

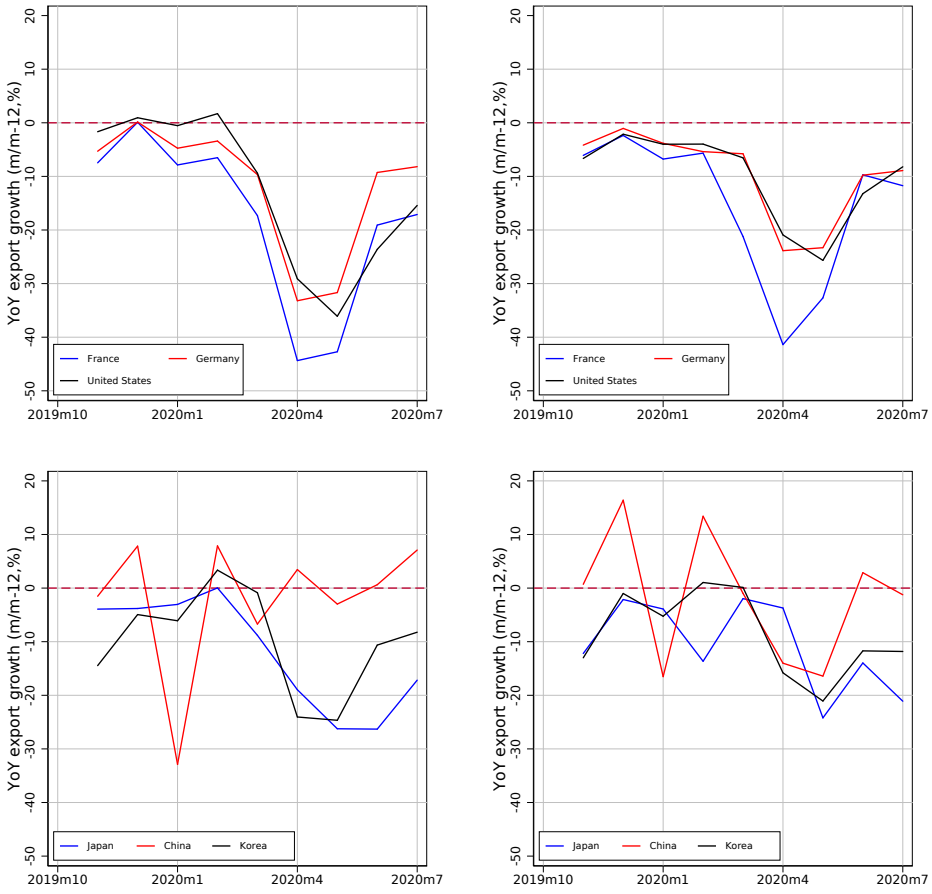
In Asia, the situation was more contrasted between China on the one hand, and Korea/Japan on the other hand. While Chinese trade recovered quickly after a drop early in the year, Korean and Japanese trade flows kept shrinking year-on-year throughout the summer of 2020. Chinese imports then started a sharp decline again in April / May, which may be explained by supply shortages in Chinese trade partners.[2]

We present in Figure 5 a scatter plot of the empirical relation between the lockdown stringency reported for the reporting countries from our trade dataset, and the exports and import variation between April 2019 and April 2020. Export and import growth are both strongly negatively correlated with lockdown stringency, which may signal that the lockdown during the pandemic impacted both exports and imports through supply and demand channels.

Finally, Figure 4 presents a decomposition of the aggregate export growth for the 18 reporting countries in our sample (summed over all countries) by sector. The most strongly affected sector is motor vehicles and other transport equipment, which may have suffered from import disruptions of international supply chains.

[2]China only published an aggregate of January and February 2020 trade flows. Here, we show growth rates for January and February, where the trade flows are divided equally between both months.

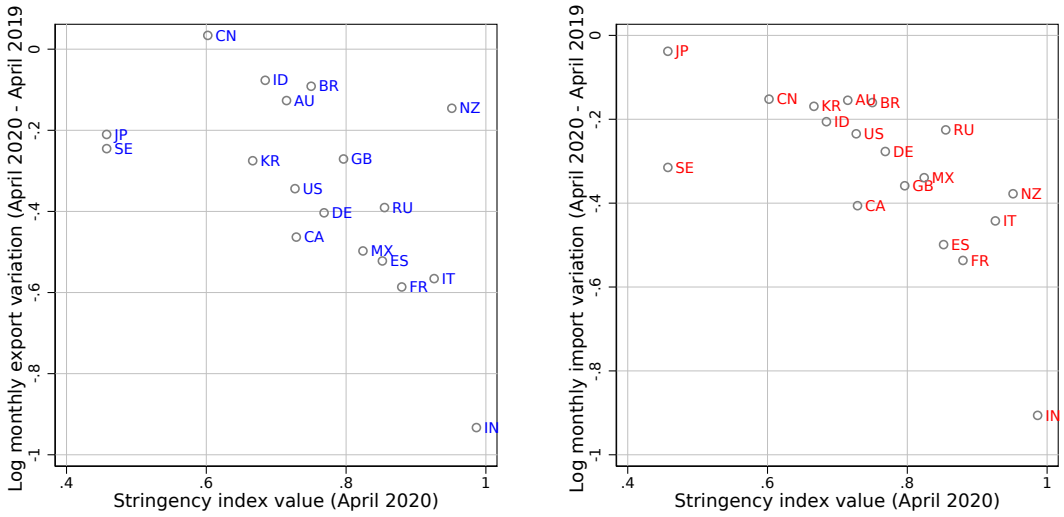
Figure 2: Aggregate export and import growth by country during the Covid crisis



(a) Exports (b) Imports

Note: Aggregate export and import growth. Raw data detailed by country pair and product from the Trade Data Monitor.

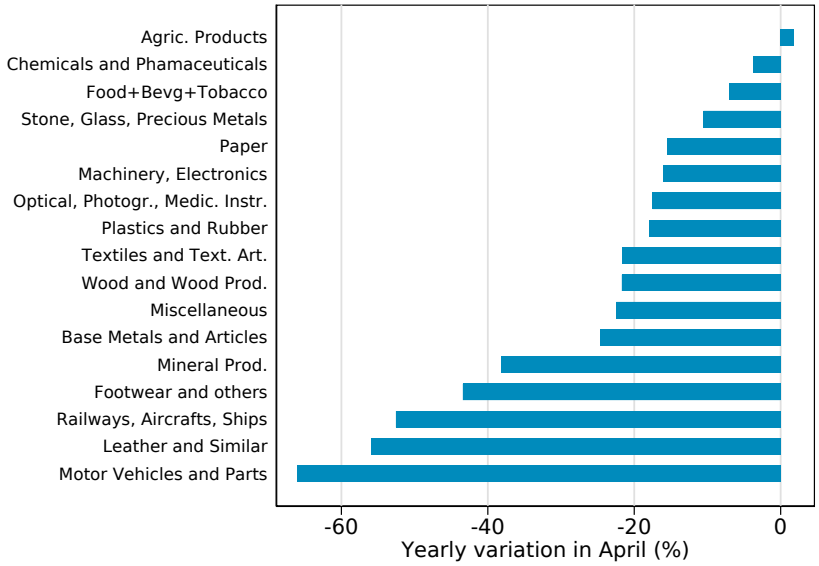
Figure 3: Relation between lockdown stringency index and trade growth



(a) Exports (b) Imports

Note: Aggregate export and import growth. Raw trade data from the Trade Data Monitor. Lockdown stringency index from the University of Oxford.

Figure 4: Export growth by sector in April (Aggregate, yoy variation)



Note: Aggregate export growth. Raw data detailed by country pair and product from the Trade Data Monitor.

3 Econometric strategy.

The estimation strategy relies on the export (X_{ijkt}) and import (M_{ijkt}) data reported by 18 countries with 252 partner countries in the TDM data, where i is the reporting country, j is the partner country, k is a product (HS 2-digits in the baseline estimations, HS 6-digits when we address the question of prices versus quantity effects), t is the time dimension of the data (monthly). We merge this data with the University of Oxford's lockdown stringency index, which is updated daily. To match this index with our trade data, we take the monthly average of the index. Once merged we have over 200 potential trade parters for our 18 reporting countries.

Equation 1 is our baseline estimated equation in log levels, where the trade flow in this equation T_{ijkt} is either exports (X_{ijkt}) or imports (M_{ijkt}) of the 18 reporting countries in our sample with each potential trade partners. We estimate two parameters, which identify the trade impacts of lockdown stringency in the exporting country (β_1) and in the importing country (β_2). ϵ_{ijkt} is the error term. γ_{ijk} is a country-pair-product fixed effect that controls for all time-invariant observed or unobserved factors that would impact the intensity of the trade relation between the two trade partners in a given product category, such as price or quality competitiveness, trade costs, or preferences. γ_{km} is a product-month fixed effect to control for seasonality. γ_{ky} is a product-year fixed effect controlling for global trends in product-level trade (for instance related to global shifts of expenditure towards the consumption of certain goods). γ_t is a time fixed effect. This fixed effect will control in particular for any global (supply or demand shock) that would impact in a similar way bilateral trade flows at a certain date. Therefore, our identification is based on the cross-country differences in the implementation of lockdown measures, controlling for the average rise in restrictions at the global level.

$$\ln T_{ijkt} = \beta_1 \text{Lockdown Stringency}_{it} + \beta_2 \text{Lockdown Stringency}_{jt} + \gamma_{ijk} + \gamma_{km} + \gamma_{ky} + \gamma_t + \epsilon_{ijkt} \quad (1)$$

Note that we do not introduce in this equation the GDP of both importing or exporting countries as in a gravity framework, as both GDPs are impacted by the Covid-19 shock. So, the lockdown measures in the exporting or importing countries are expected to capture respectively the supply and demand shocks due to the pandemic. In one of the estimations reported in the results section, we rely on the detailed lockdown stringency

indexes published by the University of Oxford, rather than on the composite index, which we use in our main estimations.

In an alternative approach, we estimate the effects of the time changes in the lockdown stringency on the log variation of exports during the same period. The interest of this approach is that we are then able to explore the effects of the policy response to the pandemic at different horizons (1 month, 3 months, 12 months) and to examine if the estimated effect is symmetric or not during phases of lockdown tightening or loosening.

The estimated equation is obtained by simply taking time changes of Equation 1 at different horizons (monthly, three or twelve months variations). Taking first differences also eliminates country-pair-product fixed effects. We obtain equation 2:

$$\Delta \ln T_{ijkt} = \Delta\beta_1 \text{Lockdown Stringency}_{it} + \Delta\beta_2 \text{Lockdown Stringency}_{jt} + \eta_{km} + \eta_{ky} + \eta_t + \epsilon_{ijkt} \tag{2}$$

Finally, while our baseline equation is estimated using HS 2-digits trade data, we also present some estimations using more detailed, HS-6 digits, information. The idea here is to better capture the role of changes in values, quantities, and unit values, at the most detailed level.

4 Baseline estimation results.

4.1 Effects of lockdown stringency on bilateral trade.

Baseline estimation results are reported in Table 1. As discussed in the empirical strategy section, we report the estimation results when the reporting country is the Exporter (columns 1-3) or when the reporter is the importer (columns 4-6). We believe that this approach serves primarily as a validation of our results, but can also bring some useful and complementary information. In both cases we estimate the effects of the lockdown stringency in the exporting and importing countries.

Results confirm that the lockdown stringency in the exporting *and* importing country had a detrimental impact on bilateral trade. This result is in line with the idea that both supply and demand shocks contributed to reduce the volume of bilateral trade flows during

the great lockdown in March-May 2020. This result is robust to different combinations of fixed effects, sample of countries and products, and reference period before the pandemic period. Similar results are found based on data reported for bilateral exports or imports for our sample of 18 reporting countries, though the coefficient on exporters' stringency appear quite larger when the reporter is the exporter is one of the 18 reporting countries.

We quantify the trade effects of the lockdown by taking the estimation results presented in column (3) when both exporter and importer lockdown is introduced. Exporter and importer lockdown intensity is bounded from 0 to 1. Estimation results imply that a complete lockdown in the exporting country can result in a decline of bilateral exports to all trade partners by about 21% ($= \exp(-0.237) - 1$), while importers' stringency can lead to a decline of bilateral imports by about 27% ($= \exp(-0,312) - 1$). Supply and demand-side effects therefore appear quite symmetric. Importantly, these quantifications can be obtained for each country-pair, as it accounts for both exporter's and importer's lockckdown intensity, and controls for the average evolution of lockdown stringency in all country pairs being captured by the time dummies in the empirical model. In the quantification, the effects of exporter and importer lockdown is additive, so for to countries with the maximum score in the Oxford stringency, bilateral trade could in principle halve.

Table 1: Impact of lockdown stringency in origin and destination (period 2017-2020) countries

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. var.	Log value of monthly exports or imports reported by 18 countries					
Reporter flow	Export			Import		
Stringency index X	-0.238^a		-0.237^a	-0.181^a		-0.179^a
	(0.022)		(0.021)	(0.024)		(0.023)
Stringency index M		-0.313^a	-0.312^a		-0.255^a	-0.254^a
		(0.025)	(0.025)		(0.023)	(0.023)
R^2	0.86	0.86	0.86	0.88	0.88	0.88
Obs.	5,442,591	5,442,591	5,442,591	4,013,724	4,013,724	4,013,724
Period	2017-2020					
Fixed effects	Dyad*HS2,HS2*month,HS2*year,Time					

Note: Significance levels: ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1. Standard errors clustered by country pair. Lockdown stringency index from University of Oxford.

4.2 Non-linearity.

We next explore if these results are monotone in lockdown stringency using an alternative strategy where we stratify bins of stringency identified with dummy variables, instead of the continuous version of the Oxford stringency index. Estimation reported are reported in Table 2. When the 18 reporting countries in our data are the exporter, the estimation results confirm that the governments' responses to limit the spread of the pandemic can have significant impacts on bilateral exports and imports, even when the intensity of these measures remains limited. For a lockdown stringency index positive but below 30%, we find a significant drop in bilateral exports of about 5.5% when the reporter (among 18 countries) is the exporter. No effect however is found for a low degree of stringency in the importing country.

Results obtained so far when the reporting country is the importer tend to indicate no impact at all of weak lockdown stringency on bilateral imports.

4.3 Sub components of the Oxford stringency index.

We report in this section the results of estimations where we consider separately different components of the lockdown stringency index. These indicators reflect restrictions on schools opening (C1), workplace opening (C2), public events (C3), gatherings (C4), public transports (C5), capacity to get out from home (C6), restrictions on international movements of people (C7) or international travel (C8).

Different aspects of these restrictions could possibly impact both supply or demand. For example, schools closing can impact labor supply but also plausibly the time left for private consumption. Workplace closing can have strong impact on the supply of labor. Restrictions on public transports or restrictions on travels could possibly impact both supply or demand effects of the Covid-19 shock.

The parameters from our empirical estimations are reported in Figure 5. Two results appear. First, restrictions on public transport seem to have the strongest impact on imports and exports. Conversely, restrictions on international travel only have a very limited effect. This last result may be explained by the fact that our data does not cover trade in services. However, these results should be interpreted with caution. As the

Table 2: Impact of lockdown stringency in origin and destination countries: non-linearity

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. var.	Log value of monthly exports or imports reported by 18 countries					
Reporter flow	Export			Import		
Stringency dummy X (Score < 30)	-0.056^a		-0.056^a	0.022^b		0.021^b
	(0.013)		(0.013)	(0.010)		(0.010)
Stringency dummy X (30 >= Score < 60)	-0.088^a		-0.089^a	-0.016		-0.017
	(0.017)		(0.017)	(0.018)		(0.018)
Stringency dummy X (60 >= Score < 80)	-0.105^a		-0.104^a	-0.050^a		-0.051^a
	(0.018)		(0.019)	(0.019)		(0.019)
Stringency dummy X (Score >= 80)	-0.176^a		-0.175^a	-0.096^a		-0.096^a
	(0.021)		(0.021)	(0.021)		(0.021)
Stringency dummy M (Score < 30)		-0.003	-0.003		-0.016	-0.016
		(0.009)	(0.009)		(0.013)	(0.013)
Stringency dummy M (30 >= Score < 60)		-0.045^a	-0.047^a		-0.026	-0.026
		(0.015)	(0.015)		(0.017)	(0.017)
Stringency dummy M (60 >= Score < 80)		-0.091^a	-0.093^a		-0.080^a	-0.080^a
		(0.018)	(0.018)		(0.019)	(0.019)
Stringency dummy M (Score >= 80)		-0.190^a	-0.191^a		-0.129^a	-0.129^a
		(0.020)	(0.021)		(0.021)	(0.021)
R^2	0.86	0.86	0.86	0.88	0.88	0.88
Obs.	5,442,591	5,442,591	5,442,591	4,013,724	4,013,724	4,013,724
Period	2017-2020					
Fixed effects	Dyad*HS2,HS2*month,HS2*year,Time					

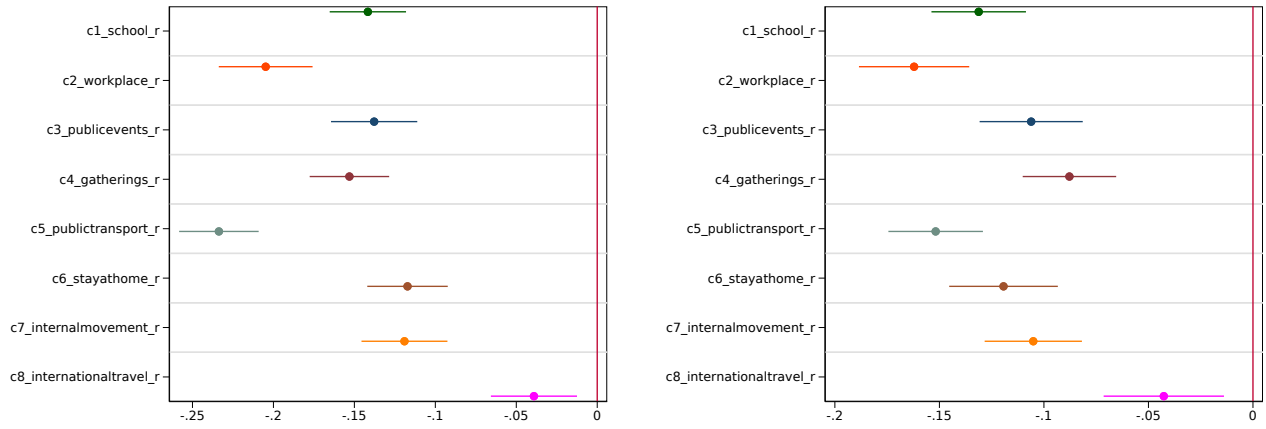
Note: Significance levels: ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1. Standard errors clustered by country pair. Lockdown stringency index from University of Oxford.

individual stringency indicators are highly correlated, it is difficult – at this stage – to assess their individual effects on trade flows.

4.4 Growth rates and asymmetry.

In this exercise, we estimate Equation 2 where the log of exports and the stringency indicators are expressed in difference to a previous month. For this exercise, we take the difference between month m and month $m-1$. The reason is that with strategy we can capture the trade effects of short term (infra-annual) changes in lockdown stringency. So, going back to Figure 1, this approach captures separately the period of the increase in lockdown stringency from January to April 2020 followed by the easing of restrictions until July, and again the introduction of new restrictions starting during the summer.

Figure 5: Elasticities for sub-components of the Lockdown Stringency Index



(a) Lockdown of the exporter

(b) Lockdown of the importer

Note: Estimation coefficients and confidence intervals using the baseline empirical specification separately for each indicator, and separately for lockdown measures in exporting and importing countries. The exporter is the reporting country.

These estimations rely on periods of strictly non-zero changes in lockdown intensity, so the data are mostly for the year 2020. Based on the data reported by our 18 economies, we firstly estimate the effects of changes in lockdown stringency upwards or downwards in the exporting country (col. 1-2) or in the importing country (col. 4-5). Estimations presented in columns 3 or 6 rely on dummy variables identifying periods of tightening or loosening of the lockdown stringency in the exporting or the importing country.

Estimation results confirm previous results obtained when the baseline estimated equation is expressed in log levels. Most importantly, the estimated coefficients show that the lockdown stringency is symmetric. For instance, in quantitative terms, the results imply that increasing lockdown in the exporting country is reducing bilateral exports by about 44% ($= \exp(-0.59) - 1$) while reducing lockdown leads to a trade recovery of about 40% ($= \exp(-0.527) - 1$). Changes in the lockdown stringency in the foreign importing country also leads qualitatively to a symmetric adjustment, though the effect of loosening lockdown stringency is less significant.

Table 3: Impact of lockdown stringency in origin and destination countries : 3-month changes

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. var.	3-month log variation of monthly exports reported by 18 countries					
Reporter flow	Export					
Lockdown variation	up	down	up or down	up	down	up or down
Var. stringency X ($m/m-3$)	-0.559^a	-0.838^a				
	(0.026)	(0.056)				
Dummy stringency X up ($m/m-3$)			-0.590^a			
			(0.026)			
Dummy stringency X down ($m/m-3$)			-0.527^a			
			(0.048)			
Var. stringency M ($m/m-3$)				-0.374^a	-0.139^c	
				(0.032)	(0.076)	
Dummy stringency M up ($m/m-3$)						-0.388^a
						(0.030)
Dummy stringency M down ($m/m-3$)						-0.113^c
						(0.064)
R^2	0.03	0.06	0.04	0.02	0.04	0.04
Obs.	601,315	112,319	713,634	559,376	108,207	667,583
Sample	Months with non-zero variation of lockdown (2020)					
Fixed effects	HS2*month,HS2*year,Time					

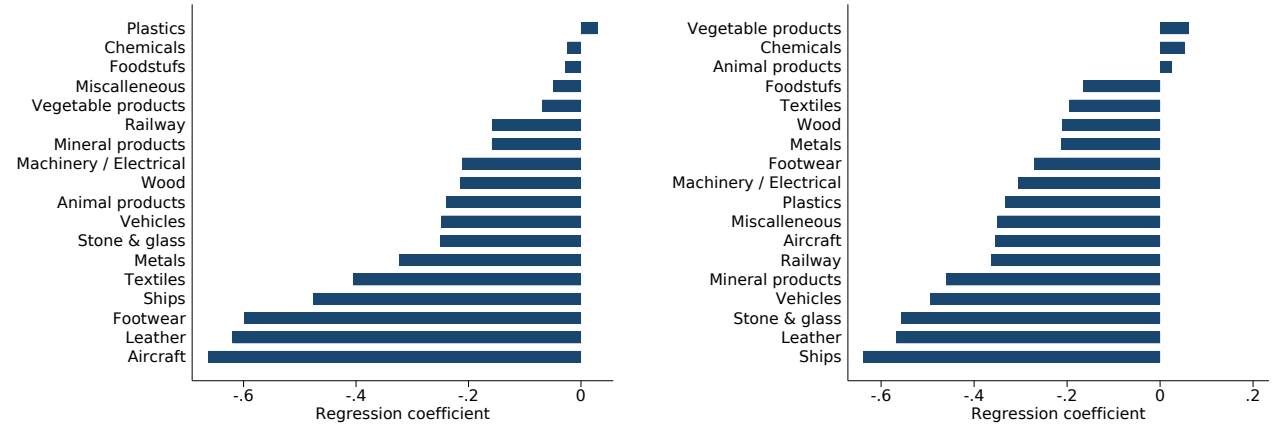
Note: Significance levels: ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1. Standard errors clustered by country pair. Lockdown stringency index from University of Oxford.

4.5 Estimation results by HS product category.

We estimate here the sectoral impact of the lockdown measures. Different sectors may have been exposed to different shocks during the spring of 2020. One example is the greater demand for medicine or masks, which were used to fight the pandemic and were associated with larger amounts of international trade (see Figure 4). On the other hand, other sectors may have been strongly impacted for different reasons, related to disruptions in global supply chains, or changes in the patterns of global demand. Our objective here is simply to provide some descriptive analysis about the response of trade within HS2 sectors consecutive to lockdown changes in exporting or importing countries.

In our empirical approach, we estimate Equation 1 separately for each HS2 sector and report the coefficients estimated in Figure 6. These estimations confirm that the lockdown had highly heterogenous impact on different sectors. Leather/footwear/textiles or

Figure 6: Regression coefficient on lockdown strngency by HS2 sector



(a) Exporter lockdown

(b) Importer lockdown

Note: Regression coefficient of the effects of lockdown stringency (exporter or importer side) by HS 2-digits sector. The estimated equation controls fr country-pair, year, month, and date fixed effects. Standard errors are clustered by country pair. Exporter and importer stringency are introduced simultaneously into the estimated equation. Trade data are from the Trade Data Monitor. Lockdown stringency index from the University of Oxford.

transport equipments such as airafts or ships seem to have suffered the most from lockdown measures taken in our 18 exporting countries, while plastics, chemicals or foodstuff suffered the less. Results are more or less similar for lockdown intensity in the importing country.

Again, this heterogenity could appear for different reasons, related to supply or demand conditions at home and abroad. National policies may also have been implemented with some heterogeneity, (i) across different regions where production is located (see for instance the US, where the pandemic during the spring firstly impacted large cities in the East coast such as New York City), and (ii) across different sectors as national governments may have encouraged the continuation of production in strategic sectors such as agriculture, food, or pharmaceutical.

4.6 Volumes versus price effects.

Finally, we present here an estimation of the volume versus price effects of the Covid-19 crisis in trade. To this aim, we use data reported at the finest level of disaggregation in the TDM data, by HS 6-digits product level. This allows to better measure unit values (as an approximation of the traded goods' price) while composition effects may impact unit values at more aggregated levels.

We start by reporting the estimation results of our main empirical equation expressed in levels. Compared to our baseline approach, exporter and importer lockdown stringency are introduced subsequently. When we introduce the exporter lockdown in the equation, the estimation controls for importer-HS6-time fixed effects, which capture changes in the lockdown stringency of the importer as well as for changes in the importer price index. Conversely, when we introduce the importer lockdown in the equation, the estimation controls for exporter-HS6-time fixed effects, which capture changes in the lockdown stringency of the exporter as well as for changes in the exporter price index.

Estimation results reported in Table 4 confirm that both exporter and importer lockdowns are strongly negatively related the exported quantity at the monthly level (see columns 2 and 5). The effects on trade unit values, however, tends to be strongly positive in the case of exporter lockdown. Conversely, the effect of importer's lockdown appears only weakly positive.

These estimation results are confirmed in alternative empirical specifications, where the empirical equation is expressed in first differences over a three-months or twelve-months period. Estimation results reported in Table 5 confirm that the lockdown stringency in the exporting economy tends to reduce strongly exported quantities while it increases the export prices. The lockdown stringency in the importing economy reduces quantities as well but has less significant impact on unit values.

The positive relation between the lockdown stringency in the exporting economy and exported unit values are in line with the consequences of a supply shock. As domestic production is altered by shortages in the labor or input supply, this tends to increase production prices and this is reflected into export prices approximated by unit values. The positive coefficient – though weakly significant one – on the importer's lockdown impact on trade unit values is more surprising, as we would expect a negative impact

Table 4: Impact of lockdown stringency in origin and destination countries : quantity versus price effect (levels)

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. var.	Log value of monthly exports reported by 18 countries					
Reporter flow	Export					
Dep. variable	Log value	Log Quantity	Log U.V.	Log value	Log Quantity	Log U.V.
Unit of obs.	Monthly level					
Stringency index X	-0.321^a	-0.758^a	0.450^a			
	(0.014)	(0.145)	(0.139)			
Stringency index M				-0.290^a	-0.329^a	0.035^a
				(0.018)	(0.019)	(0.006)
R^2	0.87	0.89	0.89	0.84	0.92	0.96
Obs.	24494050	24719148	24494049	27538687	27752278	27538686
Period	2019-2020					
Fixed effects	Importer-Exporter-HS6 Importer-HS6-time			Importer-Exporter-HS6 Exporter-HS6-time		

Note: Significance levels: ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1. Standard errors clustered by country pair. Lockdown stringency index from University of Oxford.

on trade prices of a negative demand shock. One reason might be that the supply and demand shocks due to lockdown stringency are very correlated. For instance, in the case of highly integrated global value chains, home producers sometimes export intermediate inputs that are assembled with other inputs in the foreign economy, and this new good is then re-imported and incorporates the final goods which is produced at home. In this example, the foreign shock appears both as a foreign demand and supply shock.

Table 5: Impact of lockdown stringency in origin and destination countries : quantity versus price effect (difference)

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. var.	Log value of monthly exports reported by 18 countries					
Reporter flow	Export					
Dep. variable	Log value	Log Quantity	Log U.V.	Log value	Log Quantity	Log U.V.
Var. transformation	3 month variation					
Var. stringency X $(m/m-3)$	-0.550^a	-1.852^a	1.310^a			
	(0.018)	(0.073)	(0.069)			
Var. stringency M $(m/m-3)$				-0.368^a	-0.407^a	0.036^a
				(0.021)	(0.022)	(0.006)
R^2	0.27	0.29	0.30	0.11	0.36	0.56
Obs.	18496941	18705618	18496939	21115180	21317545	21115178
Period	2019-2020					
Fixed effects	Importer-HS6-time			Exporter-HS6-time		
Dep. variable	Log value	Log Quantity	Log U.V.	Log value	Log Quantity	Log U.V.
Var. transformation	12 month variation					
Var. stringency X $(m/m-12)$	-0.051^a	-0.490^a	0.457^b			
	(0.019)	(0.189)	(0.193)			
Var. stringency M $(m/m-12)$				-0.337^a	-0.384^a	0.043^a
				(0.024)	(0.026)	(0.007)
R^2	0.26	0.28	0.29	0.09	0.51	0.72
Obs.	18210841	18415053	18210837	20791909	20990269	20791905
Period	2019-2020					
Fixed effects	Importer-HS6-time			Exporter-HS6-time		

Note: Significance levels: ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1. Standard errors clustered by country pair. Lockdown stringency index from University of Oxford.

5 The role of Global Value Chains.

5.1 Estimation results by BEC product category.

Here we investigate if the lockdown stringency impacted differently trade in intermediate inputs, capital goods or final goods (almost done).

Table 6: Impact of lockdown stringency in origin and destination countries by BEC sector

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. var.	Log value of monthly exports or imports reported by 18 countries					
Reporter flow	Export					
BEC category	Food	Industrial supplies	Fuels	Capital goods exc. transport	Transport	Consumer goods NES
Stringency index X	-0.114^b	-0.231^a	-0.162^c	-0.260^a	-0.229^a	-0.430^a
	(0.054)	(0.056)	(0.099)	(0.050)	(0.058)	(0.049)
Stringency index M	0.006	-0.148^b	-0.172	-0.158^a	-0.404^a	-0.368^a
	(0.054)	(0.059)	(0.110)	(0.052)	(0.068)	(0.054)
R^2	0.44	0.62	0.54	0.87	0.56	0.80
Obs.	333,639	207,605	135,909	231,659	303,031	301,156
Period	2017-2020					
Fixed effects	Dyad,month,year,Time					

Note: Significance levels: ^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1. Estimation by BEC sector. Standard errors clustered by country pair. Lockdown stringency index from University of Oxford.

5.2 GVCs and Covid-19: forward and backward linkages.

The demand and supply disruptions following lockdowns may have not only affected trade flows directly, but also indirectly through gobal value chains. For instance, exports of a country might be adversely affected if it cannot source intermediate inputs from abroad due to a lockdown in input-supplying countries (backward linkages). Likewise, exports may fall if the destination country uses the goods as inputs for the production of goods sold to a third country, and a lockdown in that third country reduces demand (forward linkages).

For now, we focus on forward linkages and test for their role using a global input-output framework (backward linkages to be introduced later). The output Y_{is} of country i in

sector s can be either used as intermediate input by sector $t \in \{1, ..., S\}$ in country $j \in \{1, ..., N\}$, or used for final demand in country j. The market-clearing condition is then:

$$Y_{is} = \sum_j \sum_t X^M_{ijst} + \sum_j X^C_{ijs} = \sum_j X_{ijs}$$

where $X_{ijs} = \sum_t X^M_{ijst} + X^C_{ijs}$ are total shipments from country i to country j in sector s. Let $a_{ijst} \equiv \frac{X^M_{ijst}}{Y_{jt}}$ denote expenditure on inputs from state i, industry s, as a fraction of gross output in the destination industry. We collect the coefficients in the matrix

$$\underset{S\times S}{A_{ij}} = \begin{bmatrix} a_{ij11} & a_{ij12} & \dots & a_{ij1S} \\ a_{ij21} & \ddots & & \\ \vdots & & & \\ a_{ijS1} & \dots & \dots & a_{ijSS} \end{bmatrix}$$

We can then write the global input-output matrix as follows:

$$\underset{NS\times NS}{A} = \begin{bmatrix} A_{11} & A_{12} & \dots & A_{1N} \\ A_{21} & \ddots & & \\ \vdots & & & \\ A_{N1} & \dots & \dots & A_{NN} \end{bmatrix}$$

The system of market clearing conditions can then be written as

$$Y = AY + \sum_j X^C_j = \sum_j \Omega X^C_j, \tag{3}$$

where $\Omega \equiv (I - A)^{-1}$ is the Leontief inverse, X^C_j denotes the vector of final expenditure by state j: $X^C_j = [X^C_{1j1}, X^C_{1j2}, ..., X^C_{NjS}]'$, and $Y = [Y_{11}, Y_{12}, ..., Y_{NS}]'$.

Output of sector s in country i can then be written as a function of final demand:

$$Y_{is} = \sum_{j=1}^{N} \sum_{k=1}^{N} \sum_{t=1}^{S} \omega_{ikst} X^C_{kjt} = \sum_{j=1}^{N} \phi_{ijs}$$

where ω_{ikst} are the elements of the matrix Ω. and we define $\phi_{ijs} \equiv \sum_{k=1}^{N} \sum_{t=1}^{S} \omega_{ikst} X^C_{kjt}$. ϕ_{ijs} can be understood as the amount of output (in value) by country i and sector s that

is used, directly or indirectly, to satisfy final demand in country j.

Assuming that the shock to final demand only varies at the country level, we have $\Delta \log(X^C_{kjt}) = \Delta \log(X^C_j)$, and

$$\Delta \log(Y_{is}) = \sum_j \frac{\phi_{ijs}}{Y_{is}} \Delta \log(X^C_j)$$

Using the market clearing condition for X_{ijs}, $X_{ijs} = X^C_{ijs} + \sum_t X^M_{ijst}$, and taking a first order approximation, we have

$$\begin{aligned}\Delta \log(X_{ijs}) &= \frac{X^C_{ijs}}{X_{ijs}} \Delta \log(X^C_{ijs}) + \sum_t \frac{X^M_{ijst}}{X_{ijs}} \Delta \log(Y_{jt}) \\ &= \frac{X^C_{ijs}}{X_{ijs}} \Delta \log(X^C_j) + \sum_t \frac{X^M_{ijst}}{X_{ijs}} \sum_k \frac{\phi_{jkt}}{Y_{jt}} \Delta \log(X^C_k)\end{aligned}$$

where we assume that global input-output coefficients a_{ijst} are fixed.[3]

The first term on the RHS captures direct exposure to demand shocks in state j. It equals the share of exports that is used for final demand in country j times the size of the demand shock. The second term captures all first- and higher-order indirect effects. Through these effects, exports from country i to country j may be affected by demand shocks in a third country k (the country of final demand). It equals the share of exports used as intermediate input by sector t in country j, times the share of that sector's output that is consumed, directly or indirectly, by country k, and is then summed over all recipient sectors t in country j.

We use data from the OECD global input-output framework which covers 36 sectors (among which roughly 20 tradable sectors), for 64 countries and a ROW aggregate for 2015 (the most recent year available). The global IO table is based on the ISIC Rev. 4 industry classification, and we aggregate our bilateral product-level trade flow data to that level using a HS6-ISIC Rev 4 concordance table.

We measure $\Delta \log(X^C_j)$ by the change in the lockdown stringency index, and then intro-

[3]This is exactly true in a model where the elasticity of substitution between intermediate goods and other production factors is one, and also the elasticity of substition between intermediate goods from different sectors and different origin countries is one.

duce the two RHS variables in the estimation, measuring direct and indirect exposure to demand shocks.

5.3 Upstreamness or downstreamness of product or sctor.

Report results here of upstreamness / downstreamness or centrality in production network.

6 Conclusion and discussion (TBC)

The results (still preliminary) presented in this paper show that the restrictions that impacted citizens' economic and social life at the height of the Covd-19 pandemic had a strong impact on global trade.

One important take away from this research (at this stage) is that maintaining even limited restrictions could durably impact bilateral trade flows.

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Table 7: Reporting countries from the Trada Data Monitor used in the analysis

Australia
Brazil
Canada
China
Germany
Spain
France
United Kingdom
India
Indonesia
Italy
Japan
Korea
Mexico
New Zealand
Russia
Sweden
United States

Note: Data downloaded from the Trade Data Monitor.