The factory and the hub
An anatomy of Canada's import dependence on the US*

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Abstract

We revisit the reliance of Canada on the US for its imports using new product-level data on the country of origin, the last exporting country, and the transport mode of Canadian imports. We show the US is a key supplier of Canada, but also a key logistical hub: half of the imports from non-US suppliers enter Canada through the US. Therefore, 77% of Canadian imports are tied to the US through production or logistical linkages, way above the 55% usually reported in the public debate. We show this reliance on the US is pervasive across most product categories and for Canada's main trade partners. We exploit this new measure of reliance on the US together with input-output tables to quantify the direct and indirect reliance of Canadian industries on the US through their input usage. For the average Canadian industry, the US-related content of its inputs reaches 24%. We finally discuss some policy implications of these results.

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Keywords: Import dependence; Logistical hub; Import diversification; Global value chains.

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1 Introduction

The value and the diversification of imports are often used to gauge the dependence of countries on their trade partners. The extreme events that recently hit our economies have renewed the interest in measuring such a dependence, and they have offered a new perspective on the different facets of import dependence.[1] The disruption of activities in China at the beginning of the covid-crisis has shown the reliance of many sectors and countries on Chinese *producers*. The crisis has also shown the dependence of some countries on their trade partners for *logistical* reasons. This was striking in early April 2020, when Donald Trump asked the American multinational 3M to stop exporting from the US N95 masks produced in China to Canada. The import dependence through logistical linkages has been overlooked in the literature. Our goal here is to examine these different facets of import dependence in the context of the US-Canada trade relationship.

This paper provides a forensic account of Canadian imports' dependence on the US. It examines the importance of the US both as a source of imports and as a logistical hub for Canada, and documents the heterogeneity in the logistical importance of the US for Canada across products and origin countries. It also explores the dependence of Canadian industries through their imported inputs, as well as their indirect dependence through the imported inputs of their domestic suppliers. The analysis shows that accounting for logistical linkages is crucial to have a comprehensive view of Canada's import dependence on the US.[2]

The key statistics usually discussed in the public debate is that about 55% of Canadian im-

[1] Such events include the recent pandemics or the hard-to-predict trade policy of the US administration. See Barro & Ursua (2008) on the prevalence and implications of rare disasters across countries.

[2] Note that as long as the Customs administrations release the trade data at the adequate aggregation level, our analysis can be replicated for other countries. For example, Belgium and the Netherlands, with the commercial harbors of Anvers and Rotterdam respectively, are certainly key logistical hubs for several European countries.

ports are produced in the US.[3] This figure under-estimates the dependence on the US because it misses the imports from non-US partners that reach Canada through the US for logistical reasons. Thanks to a uniquely detailed database on Canadian imports reporting information not only on the origin country of the goods (where they receive their last production stage), but also on the (final) exporting country of the goods and on their transport mode (for their last leg) to Canada, we argue that Canada's reliance on the US is greater than 55%. Half of the goods imported from non-US suppliers enter Canada through the US-Canada border. The US is thus not only the main supplier of Canada, but also a critical logistical hub for Canadian imports. Overall, 77% of Canadian imports are tied to the US, either because the goods are produced there, or because the goods cross the US to enter Canada. Such a level of dependence on the main trade partner is unique among developed economies and is not the mere reflection of the size and proximity of the US to Canada.

Indirect imports are particularly prevalent for some of the main trade partners of Canada. For example, more than 90% of the imports from Mexico, Canada's second main trade partner, are routed through the US. The reliance of Canadian imports on the US is high both as a producer and a logistical hub for printing, paper and motor vehicles products; more than 77% of Canadian imports of these products are tied to the US in the end. Imports of pharmaceutical products and textile and clothing products rely less on the US (about 50% of imports are tied to the US in these sectors).

Another feature of the data is that the value of (non-US) Canadian imports that enter through the US is relatively smaller than direct imports. This revolves to the fact that indirect imports often relate to shipments that are too small to fill an entire container to Canada, and/or that need to arrive quickly in "just-in-time" production lines, which explains why they

[3]See for instance Statistics Canada (2017).

are bought from US wholesalers or entrepôts.

Finally, we assess how much Canadian industries rely on the US for the provision of their inputs. Using input-ouptut matrices, we build a sectoral measure of dependence on the US that accounts for both the "direct" and "indirect" US-content of the inputs used by Canadian industries, i.e. the US-related inputs directly used by Canadian producers and those used by their domestic suppliers. The reliance of Canadian manufacturing sectors on inputs produced or distributed by the US is high, with significant variations across manufacturing sectors: the automobile and transport equipment industries are extremely dependent on the US, the chemical, pharmaceutical and metal product industries are less so. Even though much smaller, this dependence is also non negligible for services.

Overall, this paper shows that when one assesses the dependence of Canada on the US for the supply of its goods, focusing on the goods stamped as "produced in the US" is misleading. A non-negligible chunk of Canadian imports are tied to the US for logistical reasons. From the point of view of Canadian importers, relying on the US as a hub is certainly cost-efficient. However, this lack of diversification creates an externality for the whole Canadian economy which is greatly exposed to the consequences of disasters hitting the US, disasters that are likely not internalized by Canadian firms since they are rare and hard to predict.[4] We do not take any normative stance here since fully quantifying the benefits and the costs of the import dependence of Canada on the US goes beyond the scope of our study. However, we believe that our results provide a fresh view on the question of the diversification of Canadian imports away from the US as they point out logistical diversification as a complement to traditional supplier diversification.

[4]See Mackowiak & Wiederholt (2018) on the unpreparedness to rare events of decision-makers under rational inattention.

Related literature. Our paper speaks to different strands of the literature. First, it relates to the literature on the diversification of trade flows. Part of this literature deals with the interconnections between international trade, sector diversification of production, output volatility and growth (see, e.g., di Giovanni & Levchenko 2009, Cadot et al. 2011). The geographic diversification of trade flows is less studied, and when it is, the main focus is on the export side. For example, Caselli et al. (2020) show that the geographic diversification of exports allows to reduce the volatility of the demand faced by domestic producers, and Martin & Mayneris (2015) examines the relationship between the quality of exports and their geographic diversification. An exception is Cadot et al. (2014) who relate the search process for high-quality suppliers by OECD buyers to the patterns of geographic diversification of OECD countries' imports. We adopt a different view here by documenting the high dependence of Canada for its imports on a single trade partner, the US, and by showing that this dependence is not only related to sourcing strategies but also to logistical reasons.[5]

Our paper also participates to the literature on "indirect trade". Traded goods are not always directly shipped from the producer to the buyer. They might travel through a third country for reasons related to tariff evasion (Rotunno et al. 2013), fiscal evasion (Laffitte & Toubal 2019) or logistics (Ganapati et al. 2020). In particular, based on very detailed data on the containers shipped to the US, Ganapati et al. (2020) show that the majority of US imports that travel by the sea arrive in US ports indirectly. Indeed, the country of origin of the goods is not necessarily the country where the shipment was loaded onto the container ship, and/or the container ship makes multiple stops in different countries before reaching the US. The authors relate these patterns to the fact that shipping activities "are concentrated at entrepôts, trading hubs where goods travel through–from other origins, and

[5]See Beaulieu & Song (2015) for an analysis of Canada's reliance on the US for its exports.

bound for other destinations". Our data is less detailed and the type of indirectness we can capture is slightly different from what they have, but our paper revolves to the same idea that part of international trade is indirect which can be explained by cost-saving considerations in presence of scale economies in the shipping industry. We show that in the case of Canada, the side effect of these logistical considerations is that they increase the dependence of the country on the US.

Our paper also contributes to the literature on the measurement of sectoral exposure to foreign shocks through input usage. For instance, Boehm et al. (2019) show that Japanese affiliates in the US were strongly affected by the 2011 Tohoku earthquake because they sourced their inputs from Japan. Here, we do not look at the realized impact of a US shock on Canadian sectors, but we measure their ex-ante reliance on the US by considering the share of their inputs that are directly or indirectly tied to the US. Our measure of sectoral reliance builds on input-output (I-O) tables. The manipulation of I-O tables to go beyond raw exports and imports statistics is now well established in the trade literature (see Johnson 2018, for a review). For example, it has been recently used to measure the exposure of countries to the corona-shock in China through global value chains (Gerschel et al. 2020).

Finally, international trade and trade policy are important for Canada which is a small open economy. Canadian trade policy has been the subject of several studies with an economic history perspective (Alexander & Keay 2018, 2019), or more recently with impact evaluations of the Canada-US free trade agreement of the late 1980's (Trefler 2004, Lileeva & Trefler 2010). These papers focus on tariff barriers and they do not deal with the logistical dimension we are emphasizing here. Cardoso & Malloy (2021) provide an evaluation of the impact of Covid-19 on the trade flows between Canadian provinces and US states, but they do not discuss the specificity of the Canada-US relationship in terms of the magnitude and the nature of trade.

Recent policy works from Global Affairs Canada propose indices to assess the vulnerability of Canadian industries to disruptions in global supply chains (Boileau & Sydor 2020) and the logistics vulnerability of Canadian industries' supply chains (Jiang & Scarffe 2021); our study proposes a focus on the Canadian import dependence on the US and we propose a measure of exposure that accounts for both direct and indirect exposure through domestic suppliers' imported inputs.

The rest of the paper is organized as follows. We present in section 2 the data and some definitions we use throughout the analysis. Section 3 examines the importance of the US both as a supplier and as a logistical hub for Canadian imports. It also sheds light on the origin countries and the sectors for which the reliance of Canada on the US as a supplier and/or a logistical hub is the most important. Section 4 documents the dependence of Canadian industries on the US for input provision. We conclude the analysis with a discussion of some policy implications in section 5.

2 Data and definitions

The main database we use for the analysis is the Canadian International Merchandise Trade Database released by Statistics Canada. We use special tabulations provided for the year 2015 reporting the value and the quantity of Canadian imports disaggregated by 6-digit product in the Harmonized System (HS) nomenclature, the country of origin (where the last production step occurs), the exporting country (whose customs, but not necessarily borders, are the last to be crossed before reaching Canada), the transport mode on the last leg to Canada, and the port of entry.

The information on the origin country, the exporting country and the transport mode (for

the last leg) of the goods that enter Canada allows us us to track the Canadian imports that go through the US on their way to Canada without being produced there. We distinguish two types of such indirect imports that are tied to the US for logistical reasons. First, a product might be exported by the US but not produced in this country. In the following, we refer to this situation as imports from a US "export platform" (they are also sometimes called "re-exports").[6] Second, there are "in-transit" imports. These imports are flagged neither as having a US origin nor as being imported from the US, but they enter Canada through the Canada-US ground border, i.e. their registered transport mode is "road" or "rail" (the only ground border of Canada being with the US). Unlike the imports from a "US platform", in-transit shipments are not recorded in the US statistics.[7]

In the end, we can identify in the data three types of Canadian manufacturing imports that are related to the US: i) the goods that are produced in the US (M_{us}^{ca}); ii) the goods that are produced in country o (outside of the US) but are exported to Canada via US logistical platforms ($MP_{o,us}^{ca}$); and iii) the goods that are neither produced in the US nor shipped to Canada through a US logistical platform, but transit through the US on their way to Canada ($MT_{o,us}^{ca}$).[8]

The dataset does not report whether trade flows are intra-firm or arm's lenght. The

[6]The formal definition given by the Census is the following: "Exports of foreign goods (re-exports) consist of commodities of foreign origin that have previously been admitted to a U.S. Foreign Trade Zones or entered the United States for consumption, including entry into a CBP bonded warehouse, and which, at the time of exportation, are in substantially the same condition as when imported" (see https://www.census.gov/foreign-trade/reference/definitions/index.html).
Note that some of the imports we label as "export platform" might also be imports of products who received so production steps in the US but not enough to be considered as produced in the US based on the NAFTA rules of origin.

[7]The US Census' definition for this type of trade flows is: "Goods shipped through the United States, Puerto Rico, or the U.S. Virgin Islands from one foreign country or area to another foreign country or area without entering the consumption channels of the United States. In-transit shipments should not be part of the U.S. international trade data" (see https://www.census.gov/foreign-trade/reference/definitions/index.html).

[8]Note the data do not allow us to track in-transit imports that enter Canada by air through US airports. Our measure of the reliance of Canada on the US should thus be seen as a lower bound.

prevalence of intra-firm trade is likely to differ across products and countries of origin. However, whether exposure to intra-firm trade is more or less prone to shock transmission than exposure to arm's length trade is unclear in the literature (Kleinert et al. 2015, Alviarez et al. 2021).

We use several other databases for different parts of the analysis. The UN Comtrade and the BACI databases are used to obtain bilateral trade flows at the HS6-product level for more than 200 countries. The former is maintained by the United Nations from national Customs data; we use a version that registers export flows by exporting countries (i.e. it includes direct exports and export platform shipments in the export flows). The latter is built and maintained by CEPII[9] based on UN Comtrade data and registers export flows by supplying countries (shipments that reach their destination through an export platform are registered at the level of the country where the good receives its last production step).

Finally, the input-output table for Canada that is used to compute the sectoral index of dependence on US-related inputs is taken from the WIOD.[10]

3 The reliance of Canadian imports on the US

This section first shows that ignoring the indirect imports that go through the US leads to a severe under-estimation of the dependence of Canada on its southern neighbor. It also shows that this dependence is not the mere reflection of the size and proximity to Canada of the US. It then discusses how important the US is as a logistical hub for various non-US trading partners of Canada and various sectors. Last, it shows that the imports from non-US countries that reach Canada through the US are relatively smaller in value than those that

[9] Centre d'études propspectives et d'informations internationales, Paris.
[10] World Input-Output Database (see http://www.wiod.org/home).

reach Canada "directly".

3.1 The reliance of Canada on the US for its imports is worse than usually thought

We measure the reliance of Canada on the US for its imports $RELY_{us}^{ca}$ as the share of Canadian imports that are produced in or transit through the US. More formally RELY_{us}^{ca} is computed as follows:

$$RELY_{us}^{ca} = \frac{M_{us}^{ca} + MP_{o,us}^{ca} + MT_{o,us}^{ca}}{\sum_o M_o^{ca}} .$$

In 2015, as displayed in Table 2, 55.3% of the value of Canadian imports have the US as their origin country. However, an additional 13.9% of the value of Canadian imports are not produced in the US but are exported by the US, which acts as an export platform country in this case. Therefore about 70% of Canadian imports appear in customs declarations as relying on the US. This measure of dependence is incomplete relative to the $RELY_{us}^{ca}$ measure since the $MT_{o,us}^{ca}$ term is missing, but it has the advantage of being comparable with statistics for other countries.

Indeed, the COMTRADE data report the imports registered in terms of origin country on the one hand, and in terms of exporting country on the other, which allows to account for export platform trade flows. We thus compute the share of the main trade partner in terms of origin and export platform in the imports of more than 200 countries, and report the figures in Table A.1 in Appendix. Two main messages emerge from this table. First, the reliance of Canada on its main supplier, the US, is far above the average and the median observed across countries in the world, both as an origin country (56% *vs* 27% on average) and as an exporting country (70% *vs* 33% on average). Second, all of the countries that are together

with Canada at the top of the distribution in terms of reliance on their main trade partner are small and/or poor countries and islands (North Korea, Bhutan, Saint-Pierre and Miquelon, Anguilla or Andorra are a few examples), except for Mexico whose main trade partner is also the US. The huge import reliance of Canada on its main trade partner, the US, is thus very unique among developed economies. In particular, the US is far less reliant on its main trade partner, China (21.4% as an origin country and 18.4% as an exporting country).

This specificity of Canada and Mexico among high- and middle-income countries could well be the mere reflection of their specific economic geography. Canada's dependance on the US might simply reflect the size of the US market and its geographic proximity. A useful benchmark to test this explanation is the gravity equation. It has been shown to provide a strong relationship between countries' bilateral trade and their economic geography as captured by the economic size of the trading partners and the distance and other trade costs between them (Head & Mayer 2014). More specifically, we estimate the following empirical model:

$$\text{Ln Exports}_{ijp} = \alpha \text{Ln GDP}_i + \beta \text{Ln GDP}_j + \gamma \text{X}_{\text{Trade costs}_{ij}} + \mu_p + \epsilon_{ijp}$$

where the log of the exports of product p from country i to country j is explained by the size of each of the two trading partners in terms of GDP, and a battery of variables that proxy for bilateral trade costs (the matrix $\text{X}_{\text{Trade costs}_{ij}}$). Among these variables we find the bilateral distance between the trading partners as well as dummy variables identifying the pairs of countries that share a common border, an official language or a common currency, and the pairs of countries that participate in the same regional trade agreement. HS6-product fixed effects are also introduced to account for the fact that the average size of trade flows

worldwide differs across products. On top of these variables that are now common in the analysis of the determinants of trade flows, we introduce two dummy variables that identify the flows between the US and Canada ($\mathbb{1}_{\text{US}_i-\text{CAN}_j}$ for the flows where the US is the exporter and Canada the importer, and $\mathbb{1}_{\text{CAN}_i-\text{US}_j}$ for those where it is the other way around). The coefficients on these two dummies measure by how much the observed trade flows between the two countries differ from what economic geography, i.e. economic size, distance and other determinants of trade costs, predicts.

We estimate this gravity equation using the Comtrade data reporting export flows at the level of the country from where the products are finally exported to destination (and not necessarily produced). The results are reported in Table 1. The first column shows that, as expected, bigger countries trade more together (positive and significant coefficients on the GDP of both trading partners), whereas more distant countries trade less with each other (negative and significant coefficient on the bilateral distance between the two trading partners). All else equal, sharing a common border, a common language and a common currency also boosts trade flows. Moreover, it also appears that both Canadian imports from the US and Canadian exports to the US are bigger than what economic geography alone predicts, but the premium is not symmetric: the premium of US exports to Canada is stronger than the premium of Canadian exports to the US. This points at a clear asymmetry in the trade relationship between Canada and the US, to the benefit of the US. In column (2) we include exporter-product and importer-product fixed effects, which control for the size of the partner countries in terms of GDP, but also for all of the determinants of trade flows that enter the multilateral resistance terms in the structural gravity framework (Head & Mayer 2014).[11] This does not affect much the estimation of the "excess" trade between Canada and

[11] This includes comparative advantage, level of competition, access to markets and suppliers, prices etc.

the US. In column (3), we also estimate the trade premia between Mexico and the US. Our results show that there is also "excess" trade between Mexico and the US, and the premia we estimate are interestingly not that far from those we find for the Canada-US relationship even though more balanced.[12] Finally, in column (4), we also add dummies to estimate the trade premia between Canada and Mexico. This does not affect the estimates of the trade premia for the two other pairs of countries, and we find that at the HS6-product level, Canada exports less to Mexico than what economic geography predicts whereas Mexico exports slightly more to Canada. However, in terms of magnitude, the deviations from the gravity benchmark are much smaller for the Canada-Mexico trade flows than those measured for the Canada-US and Mexico-US pairs, which suggests that the North American value chain is strongly built around the US economy.

Although indicative of the extreme dependence of Canada, these figures used to compare the dependence of countries on their main trade partner miss the in-transit shipments that are impossible to track in internationally harmonized data. Coming back to the Canadian customs data, we find this type of dependence is non-negligible. Another 8.3% of Canadian imports transit through the US without being recorded in the data as part of the US exports to Canada. In total, the $RELY_{us}^{ca}$ measure of Canadian import reliance on the US amounts to 77%, which means that more than three fourth of the value of Canadian imports originates from the US in some way or another, out of which almost 22 p.p. is related to the US for logistical, and not production, matters. The reliance of Canada on the US for its import provision is thus much greater than suggested by the statistics we usually use.

[12]Note that the premia we measure are quantitatively quite big, but these high average values might hide considerable heterogeneity across sectors.

Table 1: ***Gravity determinants of bilateral trade flows***

	Ln Exports$_{ijp}$			
	(1)	(2)	(3)	(4)
Ln GDP$_i$	0.373^a			
	(0.009)			
Ln GDP$_j$	0.365^a			
	(0.007)			
Ln Distance$_{ij}$	-0.351^a	-0.804^a	-0.801^a	-0.801^a
	(0.015)	(0.019)	(0.019)	(0.019)
$\mathbb{1}_{\text{Contiguous countries}_{ij}}$	0.564^a	0.559^a	0.535^a	0.535^a
	(0.049)	(0.053)	(0.051)	(0.051)
$\mathbb{1}_{\text{Common language}_{ij}}$	0.075^b	0.371^a	0.386^a	0.386^a
	(0.032)	(0.040)	(0.039)	(0.039)
$\mathbb{1}_{\text{Regional trade agreement}_{ij}}$	0.030	0.117^a	0.113^a	0.112^a
	(0.028)	(0.033)	(0.033)	(0.033)
$\mathbb{1}_{\text{Common currency}_{ij}}$	0.137^a	0.101^c	0.107^b	0.107^b
	(0.046)	(0.054)	(0.054)	(0.054)
$\mathbb{1}_{\text{US}_i-\text{CAN}_j}$	1.427^a	1.331^a	1.398^a	1.402^a
	(0.067)	(0.136)	(0.132)	(0.132)
$\mathbb{1}_{\text{CAN}_i-\text{US}_j}$	0.614^a	0.656^a	0.713^a	0.699^a
	(0.064)	(0.181)	(0.181)	(0.181)
$\mathbb{1}_{\text{US}_i-\text{MEX}_j}$			1.122^a	1.108^a
			(0.121)	(0.121)
$\mathbb{1}_{\text{MEX}_i-\text{US}_j}$			0.996^a	1.007^a
			(0.206)	(0.205)
$\mathbb{1}_{\text{MEX}_i-\text{CAN}_j}$				0.205^c
				(0.109)
$\mathbb{1}_{\text{CAN}_i-\text{MEX}_j}$				-0.387^a
				(0.090)
HS6 Product fixed effects	yes	n.a.	n.a.	n.a.
Exporter×Product fixed effects	no	yes	yes	yes
Importer×Product fixed effects	no	yes	yes	yes
Observations	3,780,954	3,662,511	3,662,511	3,662,511
R-squared	0.274	0.612	0.612	0.612

Standard errors clustered at the importer-exporter level in parentheses

^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1

Data taken from the Comtrade database and registered at the level of the exporting country.

Table 2: ***Canadian import dependence on the US***

	Value	Share
US origin imports (M^{ca}_{us})	270	.55
US platform imports ($MP^{ca}_{o,us}$)	67.8	.14
US transit imports ($MT^{ca}_{o,us}$)	40.5	.08
Total imports	488	1

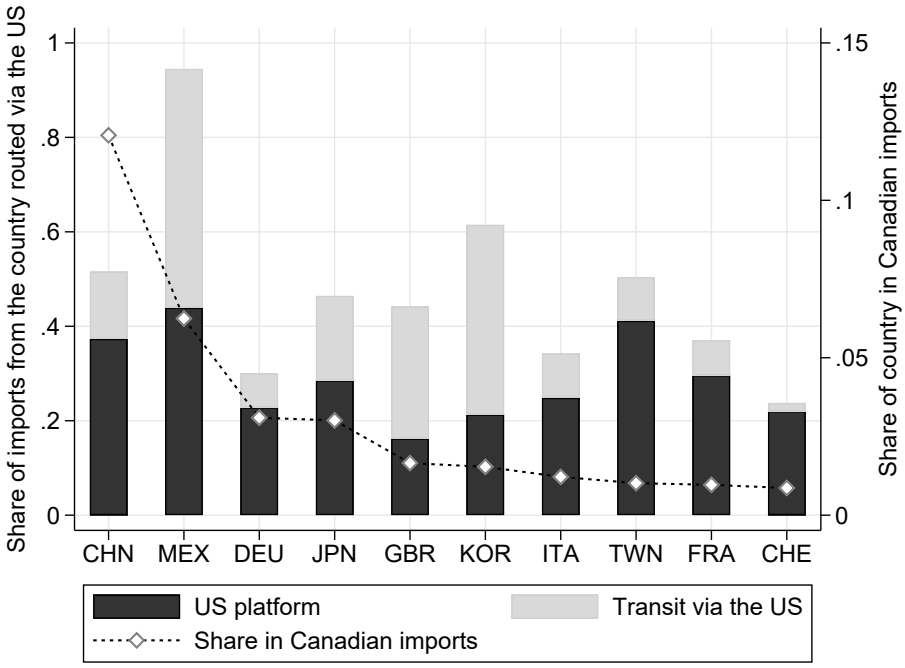
Notes: Authors' calculations from the Canadian International Merchandise Trade Database for year 2015. Figures are in billions of Canadian dollars. "US origin imports" are the imported goods produced in the US, "US platform imports" are those imported from the US but not produced there, and "US transit imports" are goods that are not produced in nor exported by the US but that enter Canada by road or rail.

3.2 US-related imports by origin country

We now explore the dependence of Canada on the US as a logistical hub for the imports from its main trade partners. Figure 1 provides information on the share of the imports from Canada's main partners that pass through the US, either through export platform or through simple ground transit. The countries are ranked in decreasing order based on their share in total Canadian imports (the main partner, the US, being of course excluded).

China and Mexico account for 12% and 6% of Canadian imports respectively, Germany and Japan around 3%, and the five other main partners between 1 and 2%. For most of these countries, the share of their exports that reach Canada through the US is close to or above 40%. For Mexico, it is actually more than 90% of its exports to Canada that transits through the US or is sent via US export platforms. The US is also a major hub for Canadian imports from China, Taiwan, and South Korea; the share of indirect imports in overall imports from these countries ranges from 50% to 60%. About 45% of the imports from Japan and the UK pass through the US. Indirect imports through the US are less prevalent for EU countries such as France, Germany, or Italy but remain non negligible (30% to 35%). The US is thus a key hub for Canadian imports from its main non-US trade partners, especially for Mexico and Asian countries.

Figure 1: ***Share of Canadian imports from its top partners routed through the US***



Notes: authors computation from Canadian customs data. Each bar represents the share of Canadian imports from a given origin that is routed through the US before entering Canada. Some of these imports are re-exported by US companies and thus recorded in US trade statistics (US plateform), some are not but they do cross the US to enter Canada (transit via the US).

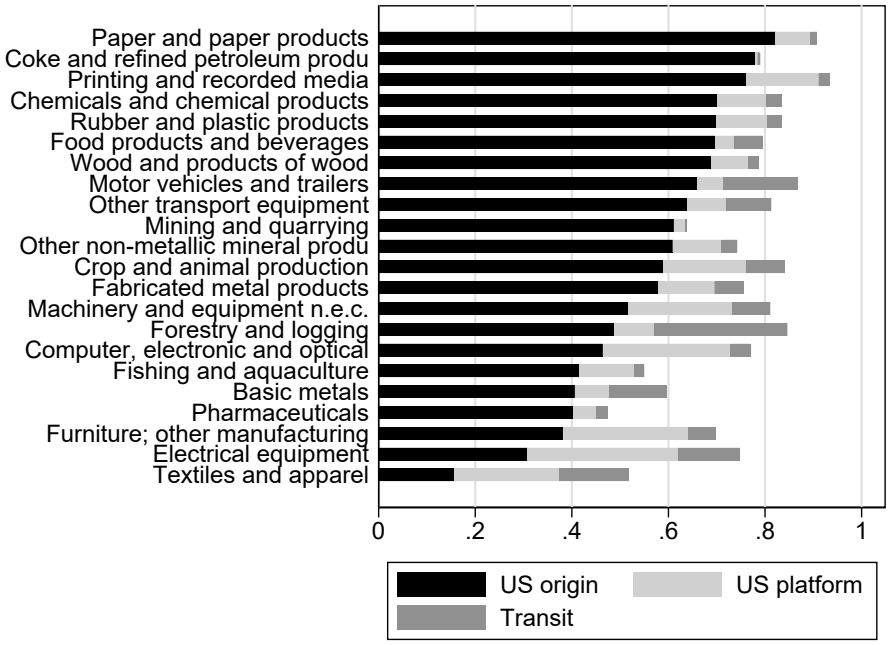
3.3 US-related imports by sector

We now turn to the description of the reliance on the US across different types of products. Figure 2 presents the import reliance of Canada on the US across (ISIC) sectors. We distinguish on this figure the three types of flows we already mentioned: US-origin (M^{ca}_{us}), US-platform ($MP^{ca}_{o,us}$), and US-transit ($MT^{ca}_{o,us}$) imports. Consistent with the aggregate figures, the share of US-related imports is high in all sectors, ranging from a bit less than 50% in the pharmaceutical industry to 90% in the printing and recorded media industry. However, the nature of this reliance varies greatly across sectors. The pharmaceutical industry and the textile and apparel industry are interesting in this respect, since the overall shares of US-related imports in these two industries are close (45-50%) but hide different patterns. The lion share of the reliance of Canada on the US in the pharmaceutical industry is driven by pharmaceutical goods produced in the US. The textile and clothing industry is quite different since only a quarter of the US-related imports actually originates from the US, the rest consisting of foreign products crossing the US en-route to Canada.

When all three types of US-related imports are accounted for, the imported goods that are the most tied to the US are in the printing industry, the paper industry, and motor vehicle industry. When we focus on US-platform and US-transit imports, electrical equipment, textile and apparel, computer-electronic-optical products, furniture, and machinery and equipment industries clearly stand out.[13] This sectoral heterogeneity in the overall reliance and the nature of this reliance on the US will generate heterogeneity across industries in their dependence on the US for the supply of their inputs (see section 4).

[13] Note that in these sectors imports often originate from Asian countries.

Figure 2: ***Three shades of exposure to the US, a sectoral view***



Notes: authors computation from Canadian customs data. US plateform are imports produced outside the US but re-exported from the US to Canada. Transit are imports produced outside the US, no recorded in US trade statistics but physically crossing the US to enter Canada.

3.4 Canadian indirect imports are smaller, in value, than direct ones

To dig deeper into the understanding of these indirect imports, we use the database on Canadian imports re-aggregated at the level of the origin country, exporting country, HS6 product and transport mode, where the transport mode simply identifies here whether the goods enter Canada by the ground (road or rail) or not.

In this database, the lines corresponding to US-platform imports (non-US origin but US-exporter) and US-transit imports (non-US origin and non-US exporter but ground transport mode) represent nearly 50% of the entries, but a bit less than 25% for the value of imports. It must be that these indirect imports are smaller in value than those for which the origin and the exporting countries are the same and the registered transport mode is not a ground one. We call these latter flows the "direct import flows".[14]

[14]Note however that this terminology is sloppy since it can be the case that imported goods are loaded on

To directly check for this, we keep the imports with a non-US origin country and we identify four types of flows: the direct flows, the US-transit flows, the US platform flows and the non-US platform flows. For a given origin country and HS6 product, we then compare the value of the transit and platform flows to the value of direct ones. Put differently, we estimate the following equation:

$$\text{Ln Imports}_{opm} = \mathbb{1}_{\text{Transit via US}_{opm}} + \mathbb{1}_{\text{Platform US}_{opm}} + \mathbb{1}_{\text{Platform non-US}_{opm}} + \mu_{op} + \epsilon_{opm}$$

where Ln Imports_{opm} is the log of Canadian imports of product p from origin country o of type m, μ_{op} is an origin country-product fixed effect and ϵ_{opm} is the error term. Moreover, $\mathbb{1}_{\text{Transit via US}_{opm}}$, $\mathbb{1}_{\text{Platform US}_{opm}}$ and $\mathbb{1}_{\text{Platform non-US}_{opm}}$ are dummies identifying the type of flow, the reference category being direct flows. The results are displayed in Table 3 and they reveal a clear-cut ranking. For a given origin country and HS6 product, the imports that transit through the US are smaller than those that are directly shipped to Canada, those that are exported from (but not produced in) the US are even smaller, and finally those that are exported from a non-US platform are the smallest ones. This holds even when we control for the GDP of the exporting country or for the fact that the goods enter Canada by the ground. Hence, even though a country has multiple ways of exporting to Canada the goods it produces, which translates into multiple entries in the Customs data for the same product and origin country, the shipments that go directly from the origin country to Canada remain the most important ones in value.

a container ship in their origin country, but then the container ship makes multiple stops to load and unload other shipments before reaching Canada. The same applies to air transport. Put differently, we do not observe the exact route taken by the container ships or the aircraft when imports are registered in the data as having the same origin and exporting country.

These patterns are coherent with insights obtained from informal discussions with people working in the freight industry who report that for shipments that are not big enough to fill a container, the least cost route to a destination is not always the direct one. In the case of Canada, the US being a much bigger market, it might well be often less expensive for exporters to load their small shipments to Canada in containers that go to the US. Also, the lean management production techniques that have become so popular in the past decades have lead producers to reduce drastically their input inventories. This might push producers who face a pressing and unforeseen need for inputs to purchase them from wholesalers located closer to them than the original producers of these inputs. In this perspective, it might be often quicker for Canadian producers to buy their inputs produced in Asia from establishments of the same multinationals located in the US (during the pandemic, some of the masks exported by 3M from the US to Canada were produced in China for example) or from American wholesalers.

4 Input dependence of Canadian industries on the US

So far, we have examined the share of Canadian imports that is tied to the US through production or logistical linkages. We have found a strong heterogeneity in this US-dependence across product categories. Since Canadian industries have different input mixes, this should translate into different levels of input dependence on the US across Canadian industries. In this section we propose a quantification of the input reliance of Canadian industries on the US. Most Canadian industries strongly rely on the US, including those that do not directly import inputs from the US because they use domestic inputs that are themselves produced with US-related inputs.

Table 3: ***Value of flows originating from non-US countries by import mode***

	Ln Imports$_{oxpt}$		
	(1)	(2)	(3)
Transit via US	-1.224^a	-1.274^a	-1.858^a
	(0.016)	(0.016)	(0.021)
Platform US	-1.213^a	-2.007^a	-2.349^a
	(0.014)	(0.021)	(0.021)
Platform non-US	-4.229^a	-4.282^a	-4.428^a
	(0.018)	(0.018)	(0.017)
Ln GDP$_{\text{Exporting country}}$		0.256^a	0.251^a
		(0.005)	(0.005)
$\mathbb{1}_{\text{Ground}}$			0.588^a
			(0.014)
Origin country-HS6 Product fixed effects	yes	yes	yes
Observations	408,126	408,126	408,126
R-squared	0.252	0.260	0.267

Robust standard errors in parentheses
^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1

4.1 Accounting framework

To measure the reliance of Canadian industries on the US, we exploit the I-O matrix describing the domestic and foreign input usage of industries. We measure reliance as the total (direct and indirect) share of US-related inputs (m_i^{us}) in total inputs (z_i) used in industry i:

$$reli_i^{us} = \frac{m_i^{us}}{z_i}$$

The total share of US-related inputs is given by the industry's direct consumption of US-related inputs plus US-related inputs that enter the production of other domestic inputs used by this industry. More specifically, the total consumption of US-related inputs in an industry is given by:

$$m_i^{us} = d_i^{us} + \sum_j \frac{x_{ji} m_j^{us}}{y_j}$$

where d_i^{us} is the direct use of US-related inputs by industry i, y_j is the production in industry j, and x_{ji} is the value of inputs j used in the production of industry i.

Let M, D, and A be the vectors and matrix with elements m_i^{us}, d_i^{us}, and $a_{ji} \equiv \frac{x_{ji}}{y_j}$. We can write:

$$M = D + AM = (I - A)^{-1}D$$

It appears from the expression above that the total use of US inputs in a industry is an infinite sum, which includes the direct use of US-related inputs, the direct use of US-related inputs by domestic inputs used in the industry, the direct use of US-related inputs used in the inputs of the inputs used in the industries, and so on and so forth:

$$m_i^{us} = d_i^{us} + \sum_j a_{ji} d_j^{us} + \sum_j a_{ji}^2 d_j^{us} + \sum_j a_{ji}^3 d_j^{us} ...$$

4.2 Empirical application and results

To measure the reliance of Canadian industries on the US for their inputs, we exploit the I-O matrix of Canada published by WIOD (Timmer et al. 2015). For every pair of industries ij, the data report the value of purchases by industry i of inputs from industry j. Key to our analysis, the data provide the break down into purchases to domestic and foreign suppliers. The matrix A is computed from the domestic requirement of the different industries.[15] To compute the direct use of US inputs, we combine I-O information with international trade data. More specifically, we compute:

[15] Our method thus excludes the reliance on the US that comes from the use of US inputs by other Canadian foreign partners.

$$d_i^{us} = \sum_j d_{ij} \times \frac{imp_j^{us}}{imp_j}$$

where d_{ij} is the value of imported inputs from industry j used by industry i, imp_j^{us} is the value of Canadian imports of products in industry j that are tied to the US and imp_j is the total value of Canadian imports of products in industry j. We thus assume that across industries, for a given input, the share of US-related imports in overall imports of that input is the same and is equal to the aggregate share of US-related imports in overall Canadian imports for the industry this input belongs to.[16]

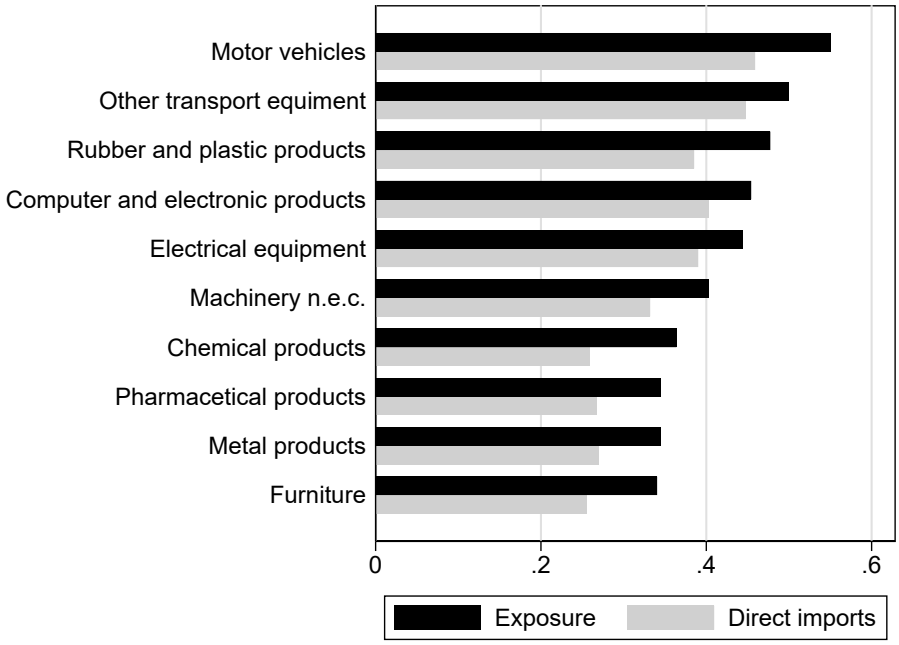
For the average Canadian industry, the US-related inputs (either because they are produced there or because they cross the US border to enter Canada) that are directly purchased by Canadian producers represent 15% of the total value of their inputs. To get a complete picture of the reliance of an industry on US-related imports, the sourcing of the producers of domestic inputs should also be considered. Once this indirect reliance on US-related imports is taken into account, we find the US-related content of the average industry increases to 24% of the total value of its inputs.

Figure 3 presents the industries that are the most exposed and Figure 4 the industries that are the least exposed to the US. The full list of sectors is presented in Table 4. The industries that rely the most on the US for their inputs are manufacturing industries such as vehicle, plastic and rubber products, or computer and electronic products. In the motor vehicle industry, overall US-related imports amounts to half the total value of inputs.

Services are among the industries that depend the least on the US, with a reliance on

[16]For instance, we assume that the share of US-related chemicals in the imports of chemicals by the textile industry is the same as the share US-related chemicals in the imports of chemicals by the car industry, and that it is equal to the share of US-related imports of chemicals in overall Canadian imports of chemicals. Note that this does not amount to assuming that the share of imported chemicals in overall chemical inputs is the same in the textile and the car industries.

Figure 3: ***Most exposed Canadian industries***



Notes: List of the ten most US-exposed industries in Canada. *Direct imports* is the share of inputs imported from the US (either produced in the US or in transit from the US). *Exposure* combines direct imports from the US and indirect exposure through the US-exposure of domestic inputs.

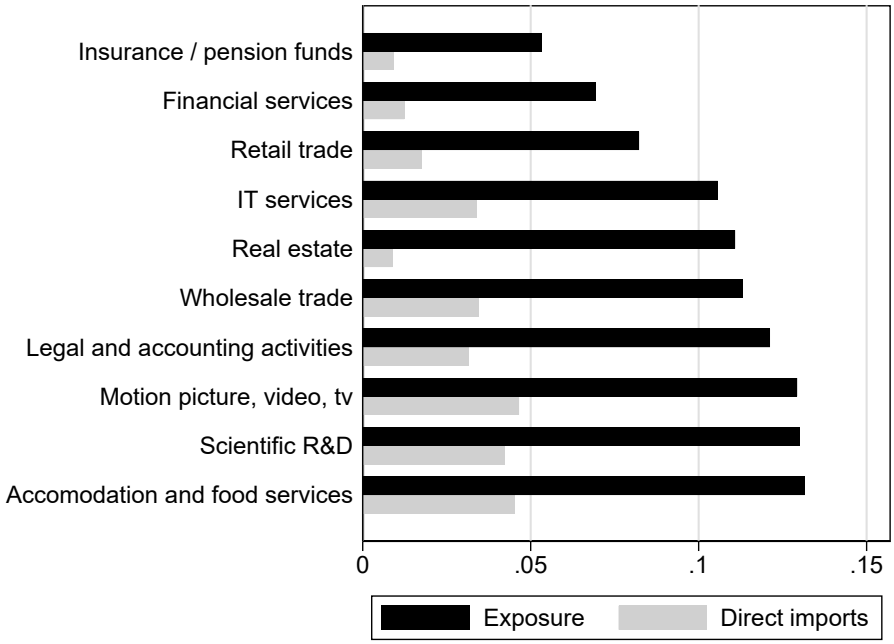
US-related inputs below 10%. However, their reliance is way above the share of US-related inputs they directly purchase. This large discrepancy is explained by the fact that services use domestic inputs from industries that rely more than they do on the US.

These results show all industries rely significantly on US-related inputs. Manufacturing industries are the most dependent, but services are not immune to trade disruption with the US either.

Table 4: ***US exposure of Canadian sectors***

ISIC sector	Direct exposure	Total exposure
Manufacture of motor vehicles, trailers and semi-t	46%	55%
Manufacture of other transport equipment	45%	50%
Manufacture of rubber and plastic products	39%	48%
Manufacture of computer, electronic and optical pr	40%	45%
Manufacture of electrical equipment	39%	44%
Manufacture of machinery and equipment n.e.c.	33%	40%
Manufacture of chemicals and chemical products	26%	36%
Manufacture of basic pharmaceutical products and p	27%	35%
Manufacture of fabricated metal products, except m	27%	34%
Manufacture of furniture; other manufacturing	26%	34%
Wholesale and retail trade and repair of motor veh	25%	34%
Sewerage; waste collection, treatment and disposal	20%	32%
Manufacture of wood and of products of wood and co	19%	30%
Manufacture of textiles, wearing apparel and leath	21%	29%
Construction	20%	28%
Manufacture of paper and paper products	17%	28%
Printing and reproduction of recorded media	18%	28%
Manufacture of coke and refined petroleum products	21%	28%
Air transport	15%	27%
Forestry and logging	15%	26%
Fishing and aquaculture	13%	24%
Manufacture of basic metals	17%	24%
Manufacture of other non-metallic mineral products	13%	24%
Crop and animal production, hunting and related se	13%	24%
Human health and social work activities	14%	22%
Mining and quarrying	15%	22%
Publishing activities	12%	21%
Water transport	8%	20%
Postal and courier activities	9%	20%
Telecommunications	13%	20%
Manufacture of food products, beverages and tobacc	8%	19%
Education	7%	19%
Electricity, gas, steam and air conditioning suppl	9%	17%
Land transport and transport via pipelines	6%	17%
Other service activities	6%	16%
Warehousing and support activities for transportat	5%	16%
Administrative and support service activities	6%	15%
Architectural and engineering activities; technica	6%	14%
Advertising and market research	4%	14%
Other professional, scientific and technical activ	5%	14%
Public administration and defence; compulsory soci	6%	14%
Accommodation and food service activities	5%	13%
Scientific research and development	4%	13%
Motion picture, video and television programme pro	5%	13%
Legal and accounting activities; activities of hea	3%	12%
Wholesale trade, except of motor vehicles and moto	3%	11%
Real estate activities	1%	11%
Computer programming, consultancy and related acti	3%	11%
Retail trade, except of motor vehicles and motorcy	2%	8%
Financial service activities, except insurance and	1%	7%
Insurance, reinsurance and pension funding, except	1%	5%
Average	15%	24%

Figure 4: ***Least exposed Canadian industries***



Notes: List of the ten least US-exposed industries in Canada. *Direct imports* is the share of inputs imported from the US (either produced in the US or in transit from the US). *Exposure* combines direct imports from the US and indirect exposure through the US-exposure of domestic inputs.

5 Concluding remarks

We show that 77% of Canadian imports are tied to the US through production or logistical linkages, way above the 55% often reported in the public debate. Such a level of import dependence is unique among developed economies.

Indirect imports through the US certainly allow Canada to reduce shipping costs by better exploiting scale economies in the freight industry, but they also generate non-negligible risks of supply disruption for Canadian consumers and producers in many manufacturing sectors. The products used in the fight against the Covid-19 pandemic are a recent example. More broadly, the past few years have shown that events that were seen as highly improbable so far, such as global pandemics, unilateral trade restrictions, end of free trade agreements, are not so unlikely in reality. To alleviate the risks associated with the Canadian import dependence

on the US, several avenues exist for policy-makers.

One possibility is to diversify imports away from the US. The negotiation and ratification of trade agreements with other countries such as the recent Canada-EU free-trade agreement and the Canada-United Kingdom trade continuity agreement are steps in this direction. Still, our results show this strategy will not be highly effective without a diversification of logistical chains. Indirect imports are partly related to small shipments for which the least-cost route is not necessarily a direct route to Canada (since they cannot fill an entire container sent to Canada). In this respect, any incentive given to firms to pool their purchases would be good. Additional costs for the treatment of small shipments at customs, or on the opposite subsidized rates for the treatment of big shipments, would play such a role. Favoring the emergence of platforms aimed at consolidating several small shipments sent to Canada (a service that some logistical firms already propose but not necessarily shipping the goods directly to Canada) could also help. Some shipments may also transit through the US because US ports, cargo airports, and custom facilities are more efficient or better equipped to welcome certain container ships or cargo aircraft. In such case, investment in transport infrastructure and custom facilities could help increase the share of Canadian imports that arrive directly to Canada. It could even reinforce some logistical platforms that could be perceived by carriers as valuable hubs to serve the North of the US. Still, all of this remains speculative. More work is needed to understand the causes of the logistical dependence we identified in this paper and think of adequate policies to reduce it.

The diversification of suppliers and logistical routes takes time, and the room for diversification might be limited by economic and geographic constraints. It is thus also important to find ways to make the Canada-US trade relationship work, and possibly work better. Anything that can strengthen the bargaining power of Canada is good in this respect. Canada is

a key supplier of the US for certain goods, so that it certainly has to gain from framing trade discussions around bundles of goods with exploitable trade-offs instead of separate discussions for every product.[17] In the same vein, given the growing tensions with China (the main producer of rare earths), Canada could leverage its resources in rare earths in a strategic way to increase its bargaining power with the US.

References

Alexander, P. D. & Keay, I. (2018), 'A general equilibrium analysis of Canada's national policy', *Explorations in Economic History* **68**(C), 1–15.

Alexander, P. D. & Keay, I. (2019), 'Responding to the First Era of Globalization: Canadian Trade Policy, 1870-1913', *The Journal of Economic History* **79**(3), 826–861.

Alviarez, V., Ceballos, B. & Swiecki, T. (2021), Cross Border Intra-Firm Trade and the Propagation of Idiosyncratic Shocks, mimeo, UBC-Sauder.

Barro, R. J. & Ursua, J. F. (2008), 'Macroeconomic Crises since 1870', *Brookings Papers on Economic Activity* **39**(1 (Spring), 255–350.

Beaulieu, E. & Song, Y. (2015), 'What Dependency Issues? Re-Examining Assumptions about Canada's Reliance on the U.S. Export Market', *SPP Research Papers* **8**(3).

Boehm, C. E., Flaaen, A. & Pandalai-Nayar, N. (2019), 'Input linkages and the transmission of shocks: Firm-level evidence from the 2011 tōhoku earthquake', *The Review of Economics and Statistics* **101**(1), 60–75.

[17] For example, when Donald Trump asked 3M not to export its masks anymore at the beginning of the Covid crisis, Justin Trudeau reminded the US that the red cedar pulp used for the production of the medical masks and gowns of 3M was currently mainly produced by Harmac Pacific in British Columbia.

Boileau, D. & Sydor, A. (2020), Vulnerability of Canadian industries to disruptions in global supply chains, Technical report, Global Affairs Canada.

Cadot, O., Carrère, C. & Strauss-Kahn, V. (2011), 'Export Diversification: What's behind the Hump?', *The Review of Economics and Statistics* **93**(2), 590–605.

Cadot, O., Carrère, C. & Strauss-Kahn, V. (2014), 'OECD imports: diversification of suppliers and quality search', *Review of World Economics (Weltwirtschaftliches Archiv)* **150**(1), 1–24.

Cardoso, M. & Malloy, B. (2021), 'Impact of the First Wave of the COVID-19 Pandemic on Trade between Canada and the United States', *Canadian Public Policy* **47**(4), 554–572.

Caselli, F., Koren, M., Lisicky, M. & Tenreyro, S. (2020), 'Diversification Through Trade', *The Quarterly Journal of Economics* **135**(1), 449–502.

di Giovanni, J. & Levchenko, A. A. (2009), 'Trade Openness and Volatility', *The Review of Economics and Statistics* **91**(3), 558–585.

Ganapati, S., Wong, W. F. & Ziv, O. (2020), Entrepôt: Hubs, Scale, and Trade Costs, CESifo Working Paper Series 8199, CESifo.

Gerschel, E., Martinez, A. & Mejean, I. (2020), Propagation of shocks in global value chains: the coronavirus case, Institut des Politiques Publiques halshs-02515364, HAL.

Head, K. & Mayer, T. (2014), Gravity Equations: Workhorse,Toolkit, and Cookbook, *in* G. Gopinath, . Helpman & K. Rogoff, eds, 'Handbook of International Economics', Vol. 4 of *Handbook of International Economics*, Elsevier, chapter 0, pp. 131–195.

Jiang, K. & Scarffe, C. (2021), Canadian supply chain logistics vulnerability, Technical report, Global Affairs Canada.

Johnson, R. C. (2018), 'Measuring Global Value Chains', *Annual Review of Economics* **10**(1), 207–236.

Kleinert, J., Martin, J. & Toubal, F. (2015), 'The Few Leading the Many: Foreign Affiliates and Business Cycle Comovement', *American Economic Journal: Macroeconomics* **7**(4), 134–159.

Laffitte, S. & Toubal, F. (2019), A Fistful of Dollars? Foreign Sales Platforms and Profit Shifting in Tax Havens, Working Papers 2019-02, CEPII research center.

Lileeva, A. & Trefler, D. (2010), 'Improved Access to Foreign Markets Raises Plant-level Productivity...For Some Plants', *The Quarterly Journal of Economics* **125**(3), 1051–1099.

Mackowiak, B. & Wiederholt, M. (2018), 'Lack of preparation for rare events', *Journal of Monetary Economics* **100**(C), 35–47.

Martin, J. & Mayneris, F. (2015), 'High-end variety exporters defying gravity: Micro facts and aggregate implications', *Journal of International Economics* **96**(1), 55–71.

Rotunno, L., Vézina, P.-L. & Wang, Z. (2013), 'The rise and fall of (Chinese) African apparel exports', *Journal of Development Economics* **105**(C), 152–163.

Statistics Canada (2017), 'Latest developments in the canadian economic accounts: Canada's merchandise trade with the u.s. by state', https://www150.statcan.gc.ca/n1/pub/13-605-x/2017001/article/14841-eng.htm.

Timmer, M. P., Dietzenbacher, E., Los, B., Stehrer, R. & de Vries, G. J. (2015), 'An illustrated user guide to the world input–output database: the case of global automotive production', *Review of International Economics* **23**(3), 575–605.

Trefler, D. (2004), 'The Long and Short of the Canada-U. S. Free Trade Agreement', *American Economic Review* **94**(4), 870–895.

A Appendix

Table A.1: ***Share of the main supplier in overall imports by country***

Importing country	Main supplier	% in overall imports (by origin country)	% in overall imports (by exporting country)
Korea, Dem. People's Rep. of	China	87	87
Cocos (Keeling) Islands	Australia	80	46
Falkland Islands	United Kingdom	79	58
Turks and Caicos Islands	United States of America	79	85
Christmas Island	Australia	73	87
Bhutan	India	71	74
Marshall Islands	Korea	70	52
St. Pierre and Miquelon	France	69	54
Anguilla	United States of America	64	71
Macau (Aomen)	Hong Kong	63	53
Andorra	Spain	63	65
Lao People's Democratic Republic	Thailand	62	56
Antigua and Barbuda	United States of America	59	19
Bermuda	Korea	58	58
Greenland	Denmark	57	62
Canada	**United States of America**	**56**	**70**
Nepal	India	56	55
Sao Tome and Principe	Portugal	55	69
Belarus	Russian Federation	54	54
Mexico	United States of America	53	65
Median across all countries		**25**	**29**
Average across all countries		**27**	**33**

Notes: The trade data by origin country come from the BACI database for the year 2015, and those by exporting country come from Comtrade for the year 2014. The origin country is the country where the goods are produced and the exporting country are the one from which they are exported.