Production Switching and Vulnerability to Protectionism[+]

Ari Van Assche[a,*] and Byron Gangnes[b]

Abstract

Many multinational firms attempt to cope with trade policy uncertainties by developing the option of manufacturing their goods in multiple production facilities in different countries. In this chapter, we explore how such "production switching" options affect the vulnerability of a country's exports to foreign protectionism. We present a theoretical model of such behavior and show that production switching increases the elasticity of a country's export with respect to tariffs. The magnitude of the elasticity depends on a country's position in the value chain. We use the model's predictions to provide new insights into the vulnerability of China's exports during the current Sino-U.S. trade war.

Keywords: global value chains, trade policy, elasticity, footloose, protectionism, China

[a] Department of International Business, HEC Montréal, Canada

[b] Department of Economics and UHERO, University of Hawaii at Manoa, United States of America

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[*]Correspondence: A. Van Assche, Department of International Business, HEC Montréal, Montréal H3T2A7, Canada. Phone: (514)340-6043. E-mail: ari.van-assche@hec.ca.

1. Introduction

> *Their [sic] is no reason for the U.S. Consumer to pay the Tariffs, which take effect on China today. […] Also, the Tariffs can be completely avoided if you by [sic] from a non-Tariffed Country, or you buy the product inside the USA (the best idea). That's Zero Tariffs. Many Tariffed companies will be leaving China for Vietnam and other such countries in Asia. That's why China wants to make a deal so badly!...*
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> —President Donald J. Trump (@realDonaldTrump) May 13, 2019

Recent years have seen a rise in protectionism. Governments began tilting the playing field in favor of local firms through selective subsidization and tariff protection in the aftermath of the 2008-2009 Global Recession (Evenett 2019). Since then, contractionary trade policies have escalated to new levels, with some of the world's largest economies putting up trade barriers. In 2016, the United Kingdom voted to exit the European Union. Since the election of President Donald Trump, the United States has, among other things, embarked on an escalating tit-for-tat tariff war with the world's second largest economy, China.

For both academics and policy makers, this new wave of protectionism has led to renewed interest in the extent to which trade barriers discourage international trade. In the field of international economics, this question is often investigated using empirical models of trade that measure the response of a country's exports to international relative price movements (Houthakker and Magee, 1969; Goldstein and Khan, 1985; Feenstra et al., 2018). In this framework, a key determinant of a country's vulnerability to a tariff hike is the degree to which foreign consumers substitute domestically produced goods for imports when relative prices change, known as the Armington elasticity. The received wisdom is that exports in homogeneous good sectors are highly sensitive to policy-induced price changes, while exports in differentiated goods sectors are relatively insensitive to protectionism (Blonigen et al., 1999; Feenstra et al., 2018). This has led scholars and policymakers to pay particular attention to the industry composition of trade flows when evaluating a country's vulnerability to foreign protectionism.

In this paper, we argue that extant studies have largely overlooked the importance of a key supply side factor—production switching—when studying trade policy using traditional trade models. Building on insights from the field of international business, we argue that the substitutability between foreign and domestic production depends not only on consumer preferences, but also on the ability of multinational firms to swiftly relocate production in the wake of a policy-induced hike in import prices. Many multinational firms attempt to cope with uncertainties related to exchange rate movements and trade policy shocks by developing the option of making a component or final good in two or more production facilities located in different countries (Kogut and Kulatilaka, 1994). As President Trump acknowledges in the quote above, a company may then switch production between locales when faced with a new trade restriction. This switching option allows multinational firms to cushion the impact of trade policy shocks on their performance. But the added substitutability between domestic and foreign production—or between alternative foreign sources of supply—can increase the vulnerability of a foreign country's exports to protectionist measures.

To study the channels through which production switching affects the elasticity of exports with respect to tariffs, we describe a mathematical model that was developed by Ma and Van Assche (2014). The model provides a number of strong predictions. First, production switching increases the elasticity of a country's exports with respect to a tariff hike. Second, the elasticity depends on the country's position in global value chains. When a country specializes in highly standardized production activities such as assembly that can be performed by multiple production plants around the world, the vulnerability of exports to trade policy shocks is magnified. When the foreign country specializes in differentiated tasks such as R&D that are difficult to replicate, the vulnerability of exports to trade policy shocks is more limited.

We then use the model's main findings to study the effect of the escalating Sino-US trade war on Chinese exports. We provide an overview of China's changing position in global value chains over the past few decades and ask what this means for multinational firms' abilities to switch production away from China. We then discuss the implications for the vulnerability of Chinese exports to U.S. tariff hikes.

2. Substitutability and the trade response to relative price change

There is a long history of economic studies that empirically evaluate the impact of trade policy measures on economic activity. These include partial and general equilibrium econometric studies as well as computable general equilibrium analyses. In each setting, at the core of the analysis is an empirical model of trade that relates trade flows to fundamental determinants suggested by theory. The traditional approach, drawing on demand theory, relates import flows to income in the home country market, domestic prices, and import prices (Goldstein and Khan, 1985). The *standard trade model* is then:

$$M = g(Y, P, PM) \qquad (1)$$

where M is aggregate import demand, Y is a measure of domestic income, P is the price of domestic goods, and PM is the price of imported goods. Depending on the context, an analogous export model may be written as:

$$X = h(eY^*, PX, eP^*) \qquad (2)$$

Where X is the demand for a county's exports, Y^* is a measure of foreign income, PX is the home export price, P^* is the price of competing foreign goods, and e is the effective exchange rate in domestic currency per unit of foreign currency.

In this framework, tariffs—or tariff-equivalent measures of other trade policies—affect trade flows by altering the relative price of foreign to domestic goods. That makes the sensitivity of imports to relative price change a key characteristic in determining the impact of protectionist measures on trade flows and the domestic and foreign economies. For the United States, for example, the price elasticity of imports is typically estimated to be about -1.0 percent (Feenstra et al., 2018), which means that all else equal a one percentage point increase in ad valorem US tariffs would lead to a one percent decrease in US imports.

The price sensitivity of import demand depends in part on the substitutability of domestic and foreign sources of supply, often referred to as the *Armington elasticity* after Armington (1969), who first laid out a tractable theory-consistent approach to modeling

trade as a demand system where products from alternative source countries are viewed as imperfectly substitutable. Armington provided separability assumptions under which we can consider trade decisions as a nested constant elasticity of substitution (CES) structure, where one models sequentially (A) the volume of imports of a good and (B) from which overseas markets imports will be sourced:[1]

$$ln\left(\frac{M}{D}\right) = \sigma\, ln\left(\frac{P}{PM}\right) + \sigma\, ln\left(\frac{1-\delta}{\delta}\right) \quad (3)$$

$$ln\left(\frac{M_j}{M_k}\right) = \sigma\, ln\left(\frac{PM_j}{PM_k}\right) + \sigma\, ln\left(\frac{\delta_j}{\delta_k}\right) \quad (4)$$

Here σ is the Armington elasticity of substitution between source country markets. *M* is total imports of the good from all sources and *D* is total domestic demand for that good. M_i refers to imports from particular source countries; similar for country-specific import prices. (The parameters δ and δ_i are weights of the composite import good and country-specific import goods in the CES utility.)

The Armington elasticity has been estimated using multilateral data as in (3) or bilateral data as in (4).[2] An early application is Hickman and Lau (1973). More recent examples include Shiells et al. (1986), Feenstra (1994), Gallaway et al. (2003), Hertel et al. (2007), Romalis (2007), and Kee et al. (2008). Studies have been conducted using both aggregate and industrially disaggregated data. In time-series specifications, often dynamic terms are added, and distinctions can be made between short-run and long-run responses (Gallaway et al., 2003).[3] Studies over the years have generated a wide range of estimates, depending on countries, industries, time period, functional form, and estimation method.

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[1] The nested CES preferences assumed by Armington (1969) are: $U = \left[\delta D^{\frac{\sigma-1}{\sigma}} + \sum \delta_i M_i^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$, where U is utility obtained from the goods, and other variables are as define in the text.

[2] Empirical trade equations extend back to the earliest days of econometric modeling, with income and relative price forms based on (1) and (2) as early as Adler (1945), Hinshaw (1945), and Chang (1946). Among periodic surveys are Goldstein and Khan (1985) and Marquez (2002). In early modeling, CES demand constraints were not imposed that would allow identification of the Armington substitution elasticity, σ.

[3] There are well-known challenges to obtaining unbiased estimates of trade price elasticities. The seminal paper is Orcutt (1950). Hillberry and Hummels (2013) review recent papers and discuss challenges related to specification, identification, data choice, and time horizon, with a particular emphasis on the importance of neglecting the supply side.

While Armington's original specification reflected in (3) and (4) imposes a common substitution elasticity among all goods regardless of source country market, the nested structure itself suggests that this is probably too restrictive. In the terminology of Feenstra et al. (2018), a "macro" Armington elasticity identifies the ease of substitution between domestic and a composite import good. That is, how easily can the representative consumer in the importing country shift consumption between domestic and imported goods as relative prices change? A second "micro" elasticity captures the degree to which importing countries can substitute between different export supply sources. Clearly both of these are important in determining effects of trade policy on the home country and alternative foreign economies.

Existing research generally suggests that the macro elasticity is smaller than the micro elasticity. There is suggestive evidence from the fact that studies using data disaggregated by industry tend to find relatively high elasticities, while studies applying aggregate data find much smaller price responsiveness (see the discussion in McDaniel and Balistreri, 2003). Feenstra et al. (2018) quote Harberger (1957) as saying that the macro elasticity "lies in or above the range of -0.5 to -1.0", and Feenstra observes that, "[i]t is fair to say that this consensus has not changed much in the ensuing quarter century." In contrast, studies of individual product groups (or that aggregate up from such detailed trade flows) tend to find much higher elasticities, averaging -5 to -10, but with considerable country and cross-sectional variety (Hummels, 2001; Hertel et al., 2004; Romalis 2007). Recent models that directly incorporate both types of elasticity within a nested CES model tend to confirm this result (Feenstra, et al., 2018; Imbs and Méjean, 2015; Aspalter, 2016), but this finding is not universal (See, e.g., Saito, 2004).

Traditional empirical models of trade, then, suggest that there may be considerable responsiveness of export flows to relative price movements, such as those associated with changed in trade policy. This will depend in part on the extent to which consumers are willing and able to substitute among products from alternative source country markets. This may differ considerably across countries and industries. However, these consumer-theory centered models ignore potentially important features of the supply-side of the

market.[4] In particular, they fail to address the way that production has been changed by the rise of global value chains (Gangnes et al., 2014; Gangnes and Van Assche, 2018). We turn in the next section to a consideration of these issues, emphasizing in particular the likely importance of opportunities for production switching behavior.

3. Global value chains and production switching

A key simplifying assumption underlying the workhorse trade model is that products have clear national identities, that is, the entire production process of a good is concentrated within a country's borders. Today this is clearly not the case. Value chains for goods and services are increasingly fragmented, with corporations dispersing activities across multiple countries and companies (Feenstra, 1998; Buckley, 2009). As a consequence, countries increasingly specialize in the production and exports of slivers of the value chain, not of entire goods (Timmer et al., 2019). This explains why intermediate inputs currently accounts for roughly two-thirds of all international trade (Johnson, 2014).

There are good reasons to believe that the sensitivity of exports to relative price changes is influenced by GVC production arrangements. For one, take the case of a reduction in prices of domestic to foreign goods, as from a depreciation of the exchange rate or a tariff hike. To the extent that production of a country's exports incorporates imported inputs (so-called *backward linkages*), the real depreciation—while making home goods more price competitive—raises the cost of imported inputs and therefore domestic production costs. In addition, when cheaper domestic value-added components are incorporated into downstream production in foreign countries (*forward linkages*), a home depreciation makes those producers more competitive. Both of these effects will tend to reduce the overall boost to the country's gross exports from the real exchange rate change. (Arndt and Huemer, 2007; Bems and Johnson, 2017; Cheng et al., 2016).

[4] A limited number of models focused on intermediate goods have been developed over the years. These models derive the demand for imported intermediates as the result of a profit maximizing (alternatively cost minimizing) choice between imports and domestic inputs. Goldstein and Khan (1985) cite Burgess (1974) and Kohli (1982); Marquez (2002) cites Kohli (1991).

There are a number of studies that find that real exchange rate effects are attenuated for countries with significant intermediate goods imports (Ahmed et al., 2015; Cheng et al., 2016; Riad et al., 2012; Arbatli and Hong, 2016; Powers and Riker, 2013.) There is considerably less research that teases out the cause of this attenuation. Cheng et al. (2016) find suggestive evidence that this is due primarily to backward linkages, rather than the position of countries in the value chain. Ceglowski (2014) and Leigh et al. (2015) find some evidence that lower price sensitivity of gross exports may be due to a lower price elasticity of intermediate goods compared with final goods. Blonigen and Wilson (1999) find that the degree of foreign ownership in downstream customers participation in GVCs may increase substitution elasticities, but that it may also introduce a bias toward parts from their home country.

In this paper, our interest extends beyond these "mechanical" effects of intermediate inputs on price elasticities. Building on insights from the field of international business, we argue that the substitutability between domestic and foreign products is also a function of the ability of a multinational firm to swiftly relocate its production activities in the wake of a trade policy shock. The following example describes how the Hong Kong-based trading company Li & Fung scrambled to restructure its GVC in response to an unexpected quota shock:

> *On a Friday in early September 2006, the South African government announced that it would be imposing strict quotas on Chinese imports in two weeks. Li & Fung had orders already in production for South African retailers that would be affected by these changes. Managers began to look at contingency plans to move production to factories in different countries and even to move the last stage of existing orders to different end countries to satisfy non-China country-of-origin rules. (Fung, Fung and Wind, 2007, 58-9.)*

The example highlights two things: (1) Li & Fung had purposefully structured its GVC so that it was possible to rapidly switch production location; and (2) the organizational flexibility allowed the company to reduce the negative impact of the unanticipated trade policy shock.

In the field of international business, there is an influential literature that has used real options theory to explain Li & Fung's behavior (see Chi et al., 2019 for a comprehensive review). According to Kogut and Kulatilaka (1994), production switching options arise when a multinational firm has the capability to make a component or final good in two or more production facilities located in different countries. They show that, in the face of exchange rate movements, having the option to switch production to a location with depreciated input costs is valuable for the multinational firm and the more so the greater the volatility in exchange rates. Belderbos and Zou (2007) find that Japanese multinational firms use the flexibility created by their multinational plant network to adjust affiliate employment in response to changes in labor costs. Chung et al. (2010) find that Japanese multinational firms make similar adjustments to employment in their multinational plant networks in reaction to country-specific fluctuations in the business cycle.

Developing the option to switch production location comes at a cost. Operating production plants in multiple locations requires multinational firms to spend additional fixed setup and management costs. Furthermore, the firm needs to make sure that all locations can replicate the same activities with little loss of productivity. While there has been relatively little work on the determinants of such *footlooseness*, existing studies suggest that production switching costs depends on technological characteristics (Grossman and Rossi-Hansberg, 2008). Routine production activities are more easily replicable in multiple locations since they can be accurately described in blueprints and engineering specifications and can more easily be inspected (Autor, Levy and Murnane, 2003; Levy and Murnane ,2004; Liu, Feils and Scholnick, 2011). Non-routine activities that require complex thinking, judgment and human interaction are more difficult to relocate since they require substantial search and development costs.

In the next section, we introduce the concept of product switching into a standard trade framework to analyze how it affects the vulnerability of a country's exports to an increase in foreign protectionism.

4. Theoretical Model

This section provides a verbal description of a mathematical model developed by Ma and Van Assche (2014). The framework builds on the firm heterogeneity models of Melitz (2003) and Chaney (2008), but provides firms the added option to assemble their final goods either in their home economy (local value chain) or in a foreign country (global value chain, GVC), and to switch location in the wake of an exogenous trade policy shock. We will demonstrate that this extra feature of production switching has significant implications for the elasticity of a country's exports with respect to tariffs.

Consider a world with two countries, "North" and "South." Consumers in North spend a fixed amount of money on a differentiated good, say, computers. Northern consumers' welfare increases when they buy more of a computer type and when they buy different computers. In the model, consumers' demand for each computer variety depends in the same way on changes in computer prices, and we assume this relationship to be independent of the overall level of consumption.

In both North and South, there are numerous computer companies, each of which has the knowledge to produce a single computer variety. An entrepreneur who wants to enter the computer sector must hire workers to develop a production technology, which in turn determines his productivity. It is unknown in advance which productivity he will receive, but the distribution of possible productivities is known to all. Once he learns his productivity, the entrepreneur determines whether to start producing. If it is profitable to produce, the entrepreneur turns into a firm. The skilled-labor cost to develop a technology equals the fixed cost of entry and is identical for all entrepreneurs.

Because firms vary in their productivity (there is firm heterogeneity), the marginal cost of production differs across computer companies. We call firms that require a relatively high amount of unskilled labor to manufacture computers low-productivity firms and those that produce a computer with less labor input high-productivity firms.

For simplicity, we assume that companies only sell their computer variety in the Northern market. Each firm sells a unique type of computer but faces competition with closely substitutable computers. The market structure is monopolistically competitive so that each firm is too small to influence overall market prices.

The value chain of a computer variety consists of three consecutive stages: input production, assembly, and sales. In the first stage, the firm uses skilled workers to develop the key input that goes into a computer, say a semiconductor component. We assume that firms must produce this input in their home country. That is, Northern and Southern firms produce the non-footloose semiconductor component in North and South respectively. In the second stage, firms use unskilled workers to assemble the computer. Assembly is footloose in that it can be performed either in North (at a high unit labor cost) or in South (at a low unit labor cost), and firms can easily switch production location. In the final stage, depending on their location, firms sell their final product either at home, to the foreign country, or in both locations.

South's cost advantage in unskilled labor provides Northern firms an incentive to offshore their computer assembly, creating a GVC.[5] Offshoring comes at a cost however. First, firms are subject to a tariff when they export computers from South to North. We assume that the tariff does not entirely wipe out the Southern labor cost advantage so that firms face a lower marginal cost when they assemble in South compared to North. Second, firms have to pay an extra fixed cost to coordinate activities across borders, which for Northern firms provides a counter-incentive to geographically separate input production and assembly.

We now consider two scenarios. First, we analyze the benchmark scenario of "no global value chains" where coordination costs are so high that all Northern and Southern firms are better off co-locating input production and assembly in their home country. Next, we study the scenario of "global value chains" where it becomes optimal for some productive Northern firms (but not all) to slice up their value chain and offshore their assembly to South. By comparing the outcomes of both scenarios, we can investigate how the ability to switch production affects the elasticity of South's exports with respect to a Northern tariff shock.

[5] Southern firms have no incentive to move assembly to North since it leads to both a higher marginal and fixed cost.

No global value chains

Consider first the case where coordination costs are so high that all Northern and Southern firms are better off co-locating input production and assembly. In this case, we effectively have a world without GVCs. As a consequence, the only firms that export from South to North are Southern firms which have produced their entire computer variety in South. In Ma and Van Assche (2014), we show that the elasticity of South's exports X^S to Northern tariffs τ takes the following form:

$$\frac{dX^S}{X^S}\frac{\tau}{d\tau} = -\frac{\varepsilon z}{\varepsilon - 1} \qquad (5)$$

where ε>1 is the elasticity of substitution between computer varieties and $z>0$ is a parameter that captures the distribution of productivities in the industry. (We will not delve deeper into z, see Ma and Van Assche, 2014, for a complete discussion). The negative coefficient in equation (5) suggests that a Northern tariff hike reduces Southern exports as Northern consumers substitute away from the relatively more expensive Southern computer varieties towards Northern computer varieties. The vulnerability of South's exports to Northern tariffs is a positive function of the elasticity of substitution between computer varieties ε. That is, in industries where consumers view product varieties as close substitutes, the tariff hike will lead to a large decrease in imports from South. In industries with a low elasticity of substitution between product varieties, the tariff increase will lead to a smaller reduction in imports from the South.

Global value chains

Consider now a situation where the fixed cost of coordinating across borders is sufficiently low that at least some more productive Northern firms find it advantageous to offshore assembly to South. In this case, two types of Northern firms will coexist in the industry: less productive firms that assemble in North, and more productive firms that assemble in South.

[Figure 1 about here]

There are two key productivity thresholds for Northern firms (see figure 1). The first threshold productivity level, *tpl,* represents the productivity at which it becomes profitable for Northern firms to start producing. Entrepreneurs with a productivity below this threshold simply do not set up firms. Entrepreneurs with productivity slightly above this threshold set up firms with assembly plants in North. The second threshold, *tpg,* is the productivity level at which it becomes profitable for firms to assemble their computer variety in South. Therefore, the less productive firms (those with a productivity between *tpl* and *tpg*) choose to produce their entire computer variety in North. The most productive firms, with a productivity above *tpg,* produce their input in North and assemble their computer in South, turning them into GVC firms. As one would expect, firm profits are positively related to firm productivity.

The decision of the more productive Northern firms to assemble in South implies that there are now two types of firms that export from South to North: Southern firms that produce their entire computer in South, and Northern multinationals that perform final assembly in South. Ma and Van Assche (2014) show that a tariff hike in North affects the exports of these two types of firms differentially. For Southern firms, the elasticity of their exports with respect to Northern tariffs is identical to equation (5). In other words, the export elasticity of Southern firms is predominantly driven by the elasticity of substitution between product varieties. For Northern multinational firms that assemble in South, however, the elasticity of exports with respect to Northern tariffs equals:

$$\frac{dX^N/d\tau}{X^N/\tau} = -\frac{\varepsilon(z+\Omega)}{\varepsilon-1} \qquad (6)$$

where the extra term Ω is a composite expression that is strictly larger than zero. (Again, see Ma and Van Assche, 2014, for details.) Comparing equations (5) and (6), we see that Northern multinationals' exports from South are always more elastic with respect to Northern tariffs than are Southern firms' exports from South. This result comes from an extra *extensive margin* effect related to production switching: as a reaction to the Northern tariff hike, a number of Northern firms that assemble in South will choose to circumvent the negative impact of the tariff shock by relocating their assembly to North. As shown in figure 2, this effectively moves the threshold productivity *tpg* further to the right.

[Figure 2 about here]

This result leads to our first proposition.

> *Proposition 1: the elasticity of exports with respect to tariffs is larger for firms that have a production-switching option than for other firms.*

The result has quite profound implications for both firms and workers. For a firm, having the option to switch production location allows it to reduce the negative impact of the tariff shock. For workers in South's assembly sector, however, it makes them more vulnerable to trade policy shock. This result is in line with Bergin et al. (2009)'s empirical finding that offshored maquiladora activities in Mexico are more vulnerable to U.S. business cycle shocks than corresponding U.S. industries.

As we discussed above, it is easier for multinational firms to develop a production switching option for production activities that are easily standardizable and replicable across multiple locations. A logical extension of proposition 1 is therefore that, if we aggregate up to the country level, the elasticity of a country's exports with respect to tariffs is larger for countries that specialize in footloose value chain activities than for those specializing in non-footloose value chain activities. We state this in proposition 2.

> *Proposition 2: the exports of countries which are specialized in footloose activities are more elastic with respect to tariffs than those of countries which specialize in non-footloose activities.*

Taken together, the model suggests that the elasticity of a country's exports with respect to foreign tariffs is not only a function of product or industry characteristics (elasticity of substitution between varieties), but also on a country's position in global value chains. In particular, the model predicts that countries that specialize in footloose activities should be more vulnerable to contractionary trade policy shocks, while countries that upgrade into less footloose value chain activities should see the vulnerability of their exports to tariffs diminish over time. In the next section, we describe China's changing position in global value chains and analyze the implications of this for the country's vulnerability to U.S. protectionism.

The astute reader while have noticed that the formal model employed here accounts only for decisions on whether to produce abroad or reshore to the home country in the face of a tariff increase. But it would be straightforward to extend the model to include decisions to relocate production from one country in the South to another location in the South not burdened with a bilateral tariff increase (see Ma and Van Assche, 2014).

5. China's changing value chain position

Donald Trump's Tweet that we quoted in the introduction was made on 10 May 2019 after he raised tariffs on $200 billion dollars' worth of Chinese exports from 10 to 25 percent. His stance was essentially that the U.S. tariffs would disproportionately hurt Chinese exporters, rather than American consumers, and that production relocation was a main reason for this: "…many tariffed companies will be leaving China for Vietnam and other such countries in Asia."

Our model provides some theoretical backing for President Trump's argument. Given China's specialization in footloose assembly activities, we would expect the country's exports to be vulnerable to multinational firms' decisions to relocate their production elsewhere in the wake of tariff shocks. We will argue in this section, however, that this view overlooks the fact that China has over the past two decades upgraded significantly its position in global value chains, moving away from simple assembly towards more sophisticated orchestration activities and input production. We conjecture that these trends are lowering the ability of multinational firms to relocate from China and that the country's vulnerability to U.S. protectionism has therefore decreased over time.

China: From world assembler …

China's integration in GVCs has long captured the imagination of economists and international business scholars. From the onset of its economic reforms in the early nineteen-eighties, China has made the attraction of labor-intensive assembly activities a key element of its export-led development strategy (Naughton, 2006). Abundant supplies

of low-cost labor combined with an undervalued currency contributed to China's comparative advantage in low-skilled assembly activities (Hanson, 2012).

One of the key mechanisms to attract assembly plants to China has been the development of a favorable export processing regime. Under China's program, firms are granted duty exemptions on imported inputs as long as they are used solely for export purposes. Unlike many neighboring countries, these concessionary provisions are not geographically limited within export processing zones, but extend to all firms on Chinese territory that have received a Processing Trade Approval Certificate (Defever and Riano, 2017). As a result, China's processing trade regime has turned into an important contributor to its overall trade performance. In the decade prior to the 2008-2009 Global Recession, the share of processing exports in China's total exports consistently hovered above 50 percent before declining to less than 40 percent over the past five years.

The combination of cheap labor and a favorable processing trade regime has allowed the country to specialize in labor-intensive assembly activities. Two stylized facts back this up. First, export processing plants rely much more heavily on imported inputs for their exports than firms that have not registered for the export processing regime. Indeed, Koopman et al. (2008) and Kee and Tang (2016) show that processing exports embodied less than half as much domestic value added in their gross exports than ordinary exports. Second, foreign-owned firms (primarily from Hong Kong and Taiwan) play a much more dominant role in China's processing trade regime than in its ordinary trade regime. Between 1997 and 2009, the share of processing exports conducted by foreign-owned enterprises increased from 64% to 85%. In comparison, this share remained under 30% in the ordinary trade regime (Ma and Van Assche, 2014).

Assembly is generally standardizable and therefore a highly footloose production activity. In line with proposition 1, we therefore should expect the elasticity of China's exports with respect to country-specific trade policy shocks to be larger for processing exports than for ordinary exports. Ma and Van Assche (2014) empirically investigate this claim by studying whether, within the same industry, Chinese processing exports are more sensitive to antidumping measures than Chinese ordinary exports during the period 1997-2009. They find strong evidence that this was the case at both the firm and province level, and observe

that this result was driven primarily by the extensive margin effect identified in the model: processing exports dropped more precipitously than ordinary exports in the wake of the imposition of antidumping measures, because more firms decided to stop exporting to the protectionist country.

… to orchestrator

Decades of rapid economic growth have made China's role as the world's assembler increasingly untenable. The country's comparative advantage in low-skilled manufacturing has been eroded gradually by rising labor costs (Ceglowski and Golub, 2012). As a consequence, China has had to move up the value chain by specializing in less standardizable activities that are more capital- and skill-intensive in nature.

A first way that Chinese exporting firms have upgraded is by taking on higher value-added orchestrating. Van Assche and Van Biesebroeck (2018) provide evidence of this by analyzing trends in the processing trade regime's two main sub-regimes: pure assembly (PA) and import and assembly (IA). Manufacturers in PA and IA share the common trait that they perform manufacturing services for third-party companies that are located overseas. However, IA firms have substantially more orchestrating responsibilities than PA firms. As we noted above, such activities are generate higher value added and are more difficult to replicate.

PA is essentially *toll manufacturing*. The assembler receives orders and materials from a foreign principal and then performs a manufacturing service on them. Once the manufacturing service has been completed, the company exports the finished good to the foreign principal and receives a processing fee, which is typically calculated as a mark-up over processing costs.

In contrast, IA refers to *contract manufacturing*. In this case, an IA assembler in China does not necessarily receive its inputs from its foreign principal, but has the responsibility of obtaining the imported materials itself prior to conducting the manufacturing service for its foreign clients. It then exports the finished products to the client and receives compensation that covers both the manufacturing service and the cost of managing input purchase and inventory.

Compared with PA firms, the contract manufacturing IA firms clearly provide a number of supplementary orchestration tasks, including selecting suppliers, coordinating the supplier network, managing inventory and input quality, and governing control rights. This requires a set of additional capabilities that are less easy to standardize and that have a higher value added (Bair & Gereffi, 2001). In line with this, Manova and Yu's (2016) find that in 2005, controlling for industry, province, ownership fixed effects and firm size, a Chinese firm's share of IA exports in processing exports is positively correlated with its productivity, capital intensity, material intensity and average wage per worker.

Van Assche and Van Biesebroeck (2018) analyze the extent to which Chinese processing firms have moved from PA to IA during the period 2000-2013. They find that the share of IA in total processing exports increased from 70% in 2000 to 82% in 2006 and then stabilized after the Global Recession. They also find that such functional upgrading in China's export processing sector has gone hand in hand with improvements in a sector's economic performance: above average growth in a sector's IA share goes together with above average growth in labor productivity and in a sector's unit values.

… and emerging input producer

A second way that firms in China have upgraded has been by gradually becoming more competitive in the intermediate input sector. Using Chinese firm level data, Kee and Tang (2016) find that individual processing exporters have increasingly substituted domestic for imported materials. They show that this substitution effect has been a response to declining relative prices of domestic to imported materials caused by the expansion of domestic input supply and quality. As a consequence, the domestic value added in Chinese processing exports grew from about 45 percent in 2000 to 55 percent by 2007.

Finally, there is recent evidence that China is moving away from reliance on the export processing regime model. Since the 2008-2009 Global Recession, the share of processing exports in China’s total exports has declined rapidly from 50 percent in 2010 to 35 percent in 2017 (Klitgaard and Wheeler, 2017). This transformation partly reflects the migration of assembly operations from China to lower-wage countries such as Vietnam,

but also the fact that Chinese firms find the processing trade regime to be less beneficial as they rely less on foreign inputs.

Due to these three trends, China's domestic content in its total exports increased from 65 to 70 percent over the 2000–2007 period (Kee and Tang, 2016). More recent data from the OECD's Trade in Value Added dataset confirm that this upward trend in domestic value added embodied in Chinese exports has continued in the aftermath of the Global Recession. The 2017 and 2019 editions use slightly different methodologies to calculate domestic value added content share in Chinese growth exports, but they both confirm that the share has continued to rise.

[Figure 3 about here]

What does all of this mean for Chinese vulnerability to protectionist trade policies? China's still-considerable reliance on lower value added assembly operations makes it vulnerable to production shifting. At the same time, it is clear that China has moved over time beyond such simple assembly tasks toward more sophisticated value chain activities that are more difficult to standardize and replicate across countries. Our model, then, suggests that China's exports are likely becoming less vulnerable to foreign trade policy shocks, as it has become more difficult for multinational firms to simply move tasks to alternative production locations.

The anecdotal evidence on the extent of production shifting in response to the recent Trump tariffs is mixed. Since the onset of the tariffs in 2018, US imports from Vietnam, an emerging low-cost producer, have increased substantially while imports from China have declined, and firms in China have explicitly cited their intent to move production there to avoid the bilateral tariffs (Moritz-Rabson, 2019). At the same time, some industries such as footwear have argued that production switching is not a viable near-term option because of the substantial capital investments that they have made in China (Meyerson, 2019). At this point, it remains unclear just how footloose overall Chinese trade is today.

6. Conclusion

Our chapter contributes to the literature on trade protectionism by exploring the mechanisms through which production switching affects the vulnerability of a country's exports to protectionist foreign actions. We have described a theoretical framework in which multinational firms can react to a contractionary trade policy shock by relocating their final assembly to another country. We have shown that production switching allows multinational firms to reduce the negative impact of the policy shock on their performance, while making the exports of lower-income countries more sensitive to these actions. The model has allowed us to develop the main proposition that a country's vulnerability to trade policy shocks not only depends on the type of goods and industries that a country specializes in, but also on its global value chain position within these industries.

We have used the model to provide new insights into the dangers that recent U.S. tariff hikes entail for Chinese exports. President Trump has recently suggested that the tariffs will disproportionately hurt China because it will push many companies to relocate their production to Vietnam and other Asian countries. We have provided evidence that the President's argument rings true, but that this may be now be changing. China indeed has historically specialized in footloose assembly activities that are relatively easy to relocate, and there is still a substantial volume of such activity within the country. But we have also shown that China has been moving away from simple assembly towards more sophisticated orchestration activities and input production that are more difficult to replicate. China's upgrading in global value chains is likely reducing the elasticity of the country's exports with respect to U.S. tariffs. In future work, we aim to empirically validate these predictions.

It is important to note that our model does not fully address the question of who bears the brunt of US protectionism. To the extent that production switching reduces the rise in production costs for multinational enterprises, it will cushion the overall rise in prices faced by US consumers. Reshoring should create some new jobs in US-based manufacturing. But the early evidence suggest that the overall cost to US consumers is still high, primarily because Chinese firms have almost entirely passed on the tariff hike by increasing their prices (Amiti et al., 2018). And there is little sign of substantial reshoring. Clearly, much more work is needed in this area.

Beyond the particular application we have studied here, our chapter demonstrates the ways in which international business scholarship can play a role in inspiring policy-relevant research (Van Assche 2018). Production switching is a firm-specific topic that has been studied in great detail in the IB field. We have demonstrated that the introduction of this concept into a standard trade model can lead to new theoretical contributions in both international business and international economics that are very relevant for current policy discussions.

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Figure 1: Two types of Northern firms: LVC and GVC

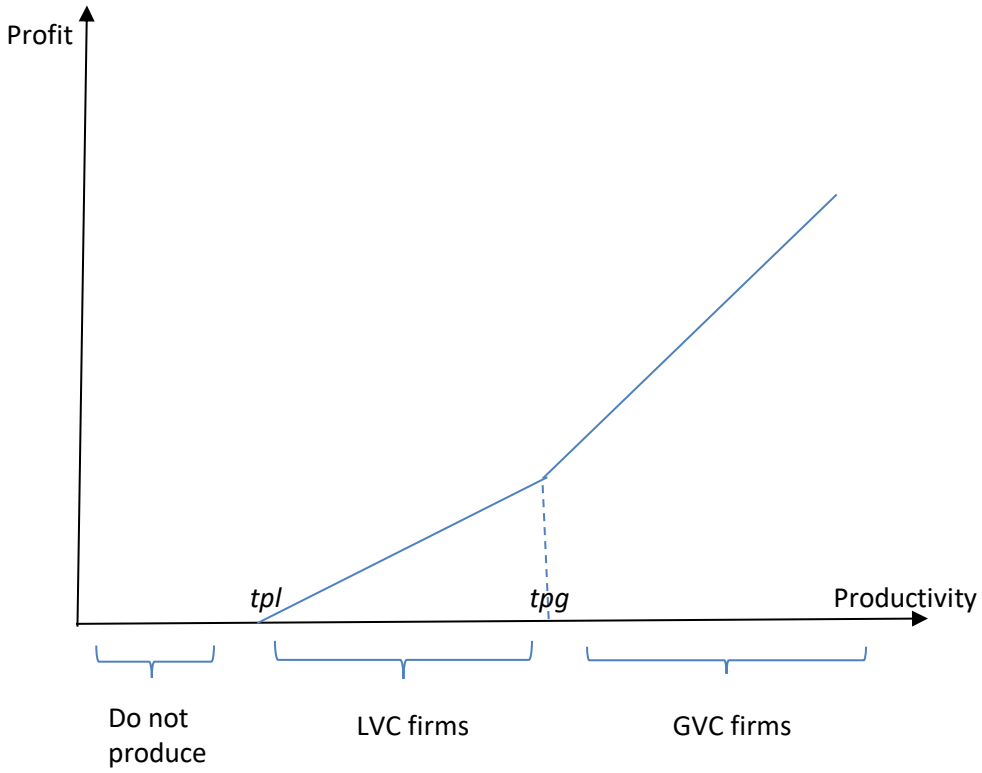


Figure 2: The effect of protectionism on profits of LVC and GVC firms

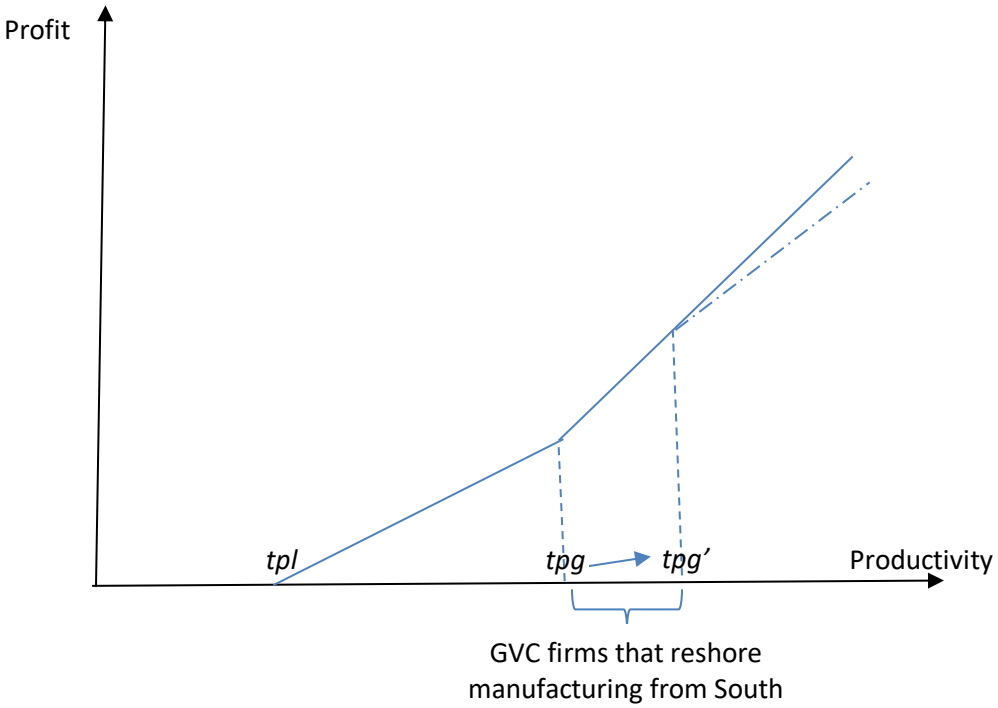
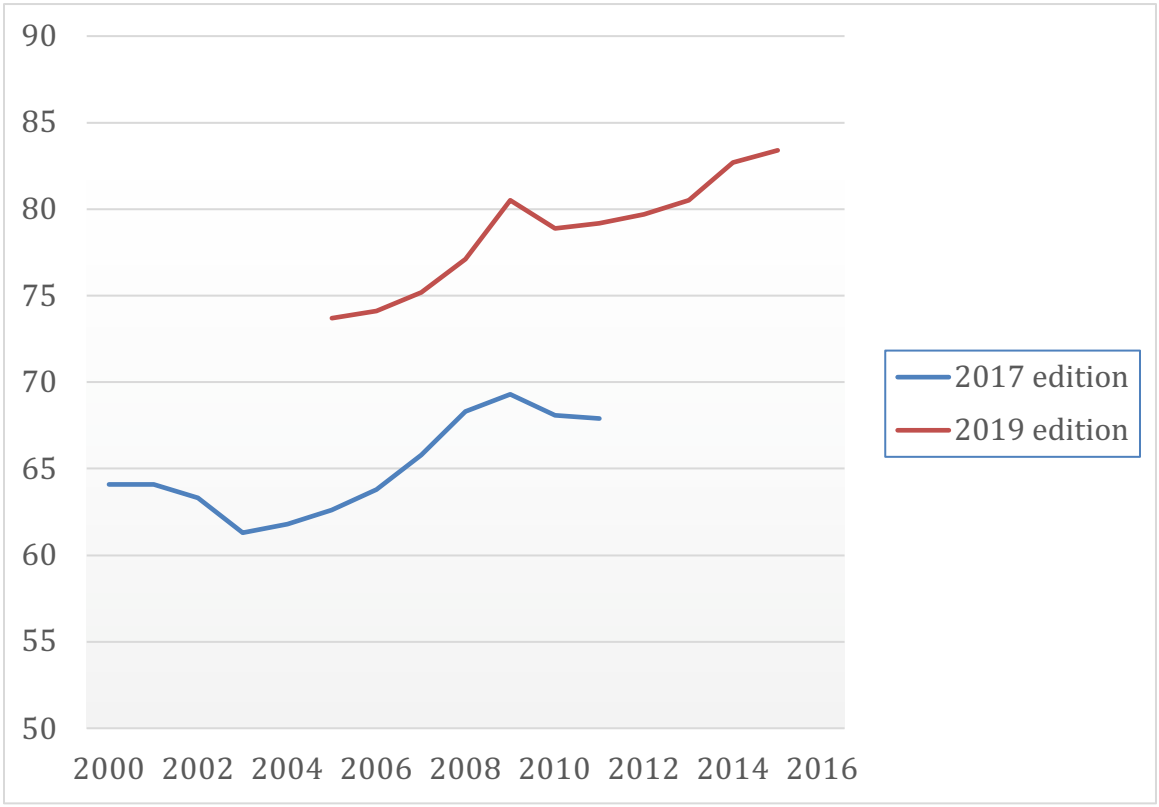


Figure 3. Share of domestic value added in China's gross exports, 2000-2016



Data Source: OECD/WTO Trade in Value Added Database