The Rules of Origin and Global Value Chains Conundrum

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Abstract – This paper studies the relationship between Global Value Chains (GVC's) and Rules of Origin (RoO's). These are two of the most prevalent features of the trade environment today but have not received a satisfying theoretical treatment, let alone one conjointly. This paper aims to fill that gap in the literature. I present a trade model with heterogeneous firms where I introduce GVC's and RoO's. I analyse the incentives a firm faces to comply with RoO's and those it faces to operate as a GVC. I then analyse how the stages of production a GVC chooses to operate is affected by RoO's. I find that the optimal number of stages of production decreases the more restrictive the RoO is, and it increases the cheaper its foreign intermediate inputs are. Lastly, I show that, all else equal, a firm operating as a GVC has a bigger incentive to comply with RoO than an exporting firm.

Keywords – trade, tariffs, rules of origin, global value chains, heterogeneous firms

1 Introduction

Recent decades have seen a large increase in Preferential Trade Agreements. We have gone from 50 agreements in 1990 to 291 agreements in 2019 (WTO). The coverage of the agreements has also increased substantially: the Transpacific Partnership and the Regional Comprehensive Economic Partnership represent respectively 40% and 30% of world trade, and include provisions for a deeper economic and political integration such as intellectual property, movement of natural persons, and competition policy. At the same time, there has been an emergence of Global Value Chains (GVC's) where firms have sliced their production processes and dispersed activities over multiple countries, through offshoring and outsourcing. An electronic good could easily cross the border multiple times, incorporating various inputs before reaching the final consumer, and be subject to different tariffs and technical requirements at each stage of the process. In this paper I study how these Global Value Chains are affected by Rules of Origin, which is one of the most important but underrated aspect of a Preferential Trade Agreement.

Rules of Origin (RoO's) are an essential part of any Preferential Trade Agreement. RoO's determine the particular transformation that a good must undergo in order to be considered "originating" and therefore be traded without paying a tariff under the Agreement. Their main purpose is to avoid trade deflection from non-Parties of the Agreement. If a firm fails to comply with the RoO, the traded good would be charged the Most Favoured Nation tariff. A typical exporter would therefore face a trade-off between paying the tariff, or complying with the RoO in order to avoid paying the tariff. In the US-CA FTA, the predecessor of NAFTA, various Canadian firms reported preferring to pay the tariff than going through the costly process of complying with the RoO (Krueger, 1993). In the case of a Global Value Chain, with the product crossing the border multiple times, this process can become much more complicated, but the rewards for complying with the RoO's can also be larger, as I demonstrate in this paper.

The topic I present in this paper gathers particular relevance in the current economic and political environment. In the 2016 US presidential election campaigns, for example, both major candidates continuously claimed the rise in job losses was largely due to foreign competition. Accordingly, President Trump abandoned TPP and forced a renegotiation of NAFTA during his first two years in power. Similarly, Autor et al. (2020) found that competition from China has contributed largely to the political polarisation in the US. More recently, we have seen that the large negative economic effects of Covid-19 have been quickly spread by our reliance on Global Value Chains.

A prime example of Global Value Chains is the auto industry in the North America region. Auto parts in the region can cross the border up to eight times before being incorporated into the final assembly, and it is estimated that between 80% and 90% of U.S. auto industry trade is intra-industry with its North American partners (Wilson Center, 2018). The recently negotiated USMCA, however, includes much more restrictive RoO's than the previous NAFTA. Mexico and Canada have therefore begun consultations with the US arguing that their automakers are not able to comply with the new rules. As the model I present in this paper predicts, some automakers would rather pay the tariff than comply with the stringent rules, and they have already announced this publicly[1].

In order to carry out the analysis, I introduce Global Value Chains and Rules of Origin in a trade model with heterogeneous firms. As in Melitz (2003), the more productive firms would earn higher revenues and would find it worthwhile to pay the fixed cost to enter the foreign market. Additionally, in this model, only the most productive of the firms would be able to pay the higher fixed cost necessary to become a GVC. Both types of firms would have the option to avoid paying the tariffs by complying with the RoO's, albeit the process being more complicated in the case of GVC's. After presenting the model, I will discuss the different incentives that the firms face both to comply with the RoO's, and to operate as a GVC. In the last section I discuss what the optimal number of stages of production would be for a GVC. I show that the stages of production are negatively affected the more restrictive the rule of origin is, and they are positively affected the less costly the foreign intermediate inputs are.

The paper proceeds as follows. In section 2, I present the literature review. Section 3 presents the theoretical framework. Section 4 presents the timing and zero profit conditions of the model. Section 5 presents the incentives that each type of firm faces. Section 6 discusses the equilibrium and presents its formal proof. Section 7 finds the optimal number of stages of production for a GVC. Section 8 discusses the implications of compliance of the RoO's for exporters and for GVC's. Section 9 concludes.

[1] https://expansion.mx/empresas/2021/09/03/bmw-pago-de-aranceles-exportar-a-eu

2 Literature Review

In this section I present the most relevant works consulted for the present paper, and explain how they relate to my research, as well as where this paper fits in in the current literature. I have separated the works into three sections: Heterogenous Firms, Rules of Origin, and Global Value Chains.

2.1 Heterogeneous Firms

Melitz (2003) is the workhorse model for dealing with heterogeneous firms and is a key paper in the "new new" trade theory literature. It introduces imperfect competition and firm level heterogeneity to explain intra industry trade and crucial differences among firms, such as why most firms do not export at all, and why only the most efficient firms export. The model builds on Krugman (1980) and incorporates heterogeneity in the marginal costs of the firm according to a probability distribution, and fixed costs of entry to every market. Preferences are given by a CES utility form and firms operate under Dixit & Stiglitz (1977) monopolistic competition, resulting in a simple but very insightful model.

While many authors have extended the Melitz model in different contexts, I present the models most closely related to the present model. Helpman et al. (2004) is an extension of Melitz (2003) and explains the decision of heterogeneous firms to serve the foreign market either through exports or through FDI. They test their predictions using data on US affiliate sales and US exports in 38 countries, confirming their results that only the most efficient firms would serve the foreign market through FDI. Helpman et al. (2004) has a more clear presentation of the model and uses the Pareto distribution in order to find a tractable solution. Their approach is particularly useful when considering the firm's decision to supply an additional market at no added trade costs.

Bustos (2011) studies the impact of MERCOSUR on the decision of Argentinian firms to upgrade their technology. She builds on Melitz (2003) by giving the firms the option to upgrade to a higher technology, both when serving the domestic mar- ket or the foreign market. The present paper applies a similar approach to hers in order to find the correct equilibrium when firms have to consider two sets of choices simultaneously.

Baldwin & Forslid (2010) study the impact of trade liberalisation using Melitz

(2003). They dissect Melitz (2003) in order to highlight its core economic logic, through its positive and normative properties, and present a number of testable hypothesis. Their analysis is very relevant in considering the impact of varying the key parameters of the model.

Melitz & Redding (2014) present an extensive survey of theoretical literature for firm heterogeneity building up on Melitz (2003). They additionally show a new source of gains from trade that is not covered in Arkolakis et al. (2012), namely trade affects welfare through reallocation across firms and within-firm productivity growth. They show that these differences are quite substantial and represent several percentage points of GDP. Melitz & Redding (2021) review the theoretical and empirical literature of trade and innovation, with special emphasis on theories of heterogeneous firms. They point to four mechanisms through which trade af-fects growth and innovation: market size, competition, comparative advantage, and knowledge spillovers. All of which offer potential static and dynamic welfare gains.

In a more empirical approach, Di Giovanni et al. (2020) study the international transmission of business cycle shocks at the firm and the aggregate levels using French firm data over the period 1993-2007. They present one micro finding and one macro finding. At the micro level, the "granular residual" accounts for 40-85% of the fluctuations in French GDP induced by foreign shocks as foreign shocks affect predominantly the largest firms in France which leads to granular fluctuations. The macro finding is that the heterogeneity across firms dampens the impact of foreign shocks, with the GDP responses 10-20% larger in a representative firm model compared to the baseline model.

Baqaee & Farhi (2020) analyse the origins of aggregate increasing returns to scale. They decompose the overala effect of a market expansion into changes in technical and allocative efficiency and use Belgian firm data to calibrate the model. Allocative efficiency changes due to three types of reallocations: reallocations across firms with heterogeneous price elasticities due to increased entry; reallocations due to the exit of marginally profitable firms; and reallocations due to changes in firms' markups. They argue that te higher aggregate efficiency in larger markets principally arises form the first type of reallocation, which acts as a "Darwinian effect" causing high- markup firms to expand relative to low-markup firms as market size increases.

2.2 Rules of Origin

Krueger (1993) is the first to provide a theoretical framework for rules of origin as FTA provisions. Her motivation is the ongoing NAFTA negotiation and the fact that the US was supporting more restrictive RoO's than Mexico and Canada. She builds on the classical Customs Union versus Free Trade Agreements Economic Theory by introducing RoO's and shows that there is a strong protectionist bias in FTA's due to RoO's. Ju & Krishna (1998) build a general equilibrium model with both traded final and intermediate goods to study the effects of RoO's, and introduce "input price effect" and a "derived demand effect" besides the usual "trade creation" and "trade diversion" effects. They find that an FTA with RoO would have the extra benefit of inducing capital flows, unlike an FTA without RoO which would only induce changes in trade flows rather than investment flows.

Estevadeordal (2000) studies the negotiating dynamics of FTA's. He presents a simultaneous equation model where the endogenous variables are the tariff phase-outs and the RoO's on the NAFTA, and claims that unlike previous literature where RoO's were regarded as having a "secondary" or "supportive" function, they are actually used as an independent policy instrument with a "primary" market access function. Importantly, he introduces a RoO restrictiveness index that has been extensively used in later literature. Estevadeordal et al. (2006) do an empirical analysis of the impact of RoO's on FDI. They focus on 122 Mexican manufacturing industries from 1994 to 2000 and use the RoO restrictiveness index. They find that highly restrictive RoO's tend to discourage FDI in Mexico.

Conconi et al. (2018) also focus on the NAFTA region. They examine the impact of RoO's on imports of intermediate goods from non-member countries. To achieve this they construct a dataset codifying the input-output linkages for each RoO in the agreement. Then they estimate triple-difference regressions exploiting cross country and cross product variation over time to account for trends in Mexican imports which might be correlated with the RoO's. They find that RoO's had a detrimental impact on imports of treated goods from non-member countries. RoO's decreased the growth rate of imports form non-members by 48 log points. "In the absence of RoO, Mexican imports of theses goods from third countries relative to NAFTA partners would have been 45 % higher".(Conconi et al., 2018)

Given that the main purpose of the RoO is to avoid trade deflection, Felbermayr et al. (2019) empirically study the profitability of such trade deflection. Using global data on tariffs, transportation costs, and FTA's, they measure the profitability of arbitrage. They find that in only 7% of the country-pair product third-country combinations trade deflection if profitable, representing 2% of GSP's and 14% of FTA's. Regarding FTA's, the difference in external tariffs would make trade deflection profitable in 30% of the cases, but in more than half of these, trade costs are too high to make arbitrage worthwhile.

Building on the classic Customs Union theory, Wooton & Haaland (2021) present a general equilibrium model with trade in intermediate and final goods and examine the implication of binding RoO's in an FTA. They focus on the role of RoO's in restricting market access for nations operating under and FTA, as opposed to those operating under a CU, which is particularly relevant in the case of Brexit. They highlight that in cases where the RoO is very restrictive, the Parties of the Agreement may be forced to source the intermediates from within the free trade region, rather than buying them from the cheapest manufacturers. They regard this as another facet of Viner's trade model, and they call it "induced trade diversion" which takes place at the level of intermediates, rather than final goods.

Krishna et al. (2021) analyse whether the cost of complying with the RoO decreases over time with the experience gathered by the firms in obtaining preferential access. They use preference utilisation rates as a proxy of the fixed cost of compliance (certification, documentation), and transaction level data on exports of Argentina and Peru to Colombia. Using the relatively recent FTA with Argentina as a natural experiment, they find that spillovers across products or importers are not evident, but spillovers within the same product, even with different imports are present. This suggests that experience in obtaining preferences does not improve the probability of obtaining preferences in other products, although it does increase it for the same product, even with different importers.

Melitz et al (2021) study whether stricter ROO promote production. They suggest that the restrictiveness of the RoO could be regarded as a Laffer Curve, in the sense that it promotes regional production up to a certain point, but after that firms actually prefer paying for the tariff than complying with the rule. To test their predictions, they use detailed sourcing data for the automobile sector in the North American region, and compare the level of compliance under the previous NAFTA and the new USMCA. In contrast, in my research, I find the optimal level of stages of production given the current RoO, and how this changes with the restrictiveness of the RoO.

The model I present in this paper is more closely related to Bombarda & Gamberoni (2013), and to Cherkashin et al. (2015). Bombarda & Gamberoni (2013) present a hub and spoke model with heterogeneous firms to study the impact of modifying the cumulation scheme in an FTA (as a proxy for relaxing RoO's). Interestingly, to test their model they look at the impact of diagonal cumulation taking as a natural experiment the Pan-European Cumulation System (PECS). Cherkashin et al. (2015) build a partial equilibrium model to explain the trade prefrences given to developing countries. They model firm heterogeneity a la Melitz and focus on Bangladeshi apparel firms which can export at the preferential level to the US but have to comply with RoO's, or alternatively to the EU without having to comply with RoO's. My work differs from both these papers by presenting a more nuanced approach on the mechanism of RoO's and by focusing on their impact on Global Value Chains.

2.3 Global Value Chains

Baldwin (2006) describes the major transformations in international trade as a sequence of two unbundlings. Rapidly falling transportation costs since the late 19th century (first unbundling) ended the necessity of making goods close to the point of consumption, but production was still clustered locally to minimise coordi- nation costs. More recently, falling communication and coordination costs (second unbundling) has ended the need to perform most manufacturing stages near each other. Baldwin (2012) presents a framework for understanging GVC's and discusses factors likely to affect their evolution, such as a the trade-off between specialisation gains and coordination costs, which is a feature we explore in the present paper when analysing the optimal number of stages of production.

Grossman & Rossi-Hansberg (2008) present a tractable model of offshoring where they introduce "task trade" to describe a finer international division of labour and to distinguish it from goods trade, with its coarser patterns of specialisation. A firm can perform each task in close proximity to its headquarters or at an offshore location. Offshoring can be attractive if some factors are cheaper abroad than at home, but it is also costly because remote performance of a task limits the opportunities for monitoring and coordinating workers. In the present paper, we model this basic trade-off when discussing the behaviour of Global Value Chains.

Koopman et al. (2012) propose an accounting framework for estimating the domestic and foreign content share in a country's exports when processing trade is pervasive, and apply it to Chinese data. Koopman et al. (2014) develop a unified framework that fully accounts for a country's gross exports by its various value added and double counted components and connect official gross statistics to value added measures of trade. Blanchard et al. (2017) explore the implications of Trade Policy on GVC's. They develop a value added approach to model tariff setting with GVC's, in which the optimal policy depends on the nationality of value added content embedded in home and foreign final goods. In the present paper we discuss both the implications of a change in tariff and a change in RoO's on GVC's in a heterogeneous firm setting.

Given the recently backlash against globalisation and the negative economic effects brought by the Covid-19 pandemic, recent literature has studied the costs and benefits of a country's reliance on GVC's. Eppinger et al. (2021) present a quantitative trade model a la Eaton & Kortum (2002) with multiple sectors, domestic and international input-output linkages, and separate trade costs for intermediate inputs and final goods. Using Data from the World Input-Output Database, they simulate GVC decoupling, which they define as increased barriers to global input trade. They find that GVC decoupling causes welfare losses ranging from -68% in Luxembourg to -3.3% in the US. The largest welfare losses being to small, integrated economies (such as Malta, Ireland, and Estonia) and the smallest to large economies that could more easily revert to their own inputs (such as China, US, and Brazil). In a similar vein, Miroudot (2020) studies data on import intensity of production, which he interprets as an index of the level of fragmentation of production, and OECD Trade in Value-Added data, and finds that there is no correlation between the level of fragmentation of production and the severity of the economic impact of Covid-19.

My research is more closely related to Van Assche & Gangnes (2019) and Amiti & Davis (2012). They both study the impact GVC's have on wages of low-skilled workers and high-skilled workers using a heterogeneous firm setting. Amiti & Davis (2012) predict that a fall in output tariffs lowers wages at import competing firms but boosts wages at exporting firms. In my research I use a similar approach to model the costs related to a good crossing the border multiple times in a GVC set- ting.

A Note on Rules of Origin

Rules of origin (RoO's) are the criteria that determine the origin of a product. Its intention is to avoid trade deflection: in order to avoid a non-signatory of a Free Trade Agreement from reaping its benefits, one determines the conditions by which a product would be considered originating from the Free Trade Area and therefore benefit from trading at a zero tariff. There are different types of rules of origin depending on the product and the trade agreement. Rules of origin can be based on a Change in Tariff Classification criteria (with regards to the Harmonised System), a Regional Value Content requirement, or a Technical Requirement (Angeli et al., 2020) . In this paper, we will model these "product specific" rules of origin as variable costs.

Besides these product specific rules of origin, a Free Trade Agreement also includes "Regime Wide" Rules of Origin which are basically the guidelines of how preferential trade is to be conducted, regardless of the product. These include the specific requirements for the certification of origin of a product (and whether it is done by the importer, the exporter, or the producer), the conditions for a verification of origin of a product, the records that a company needs to keep, etc. In this paper, we will model these "Regime Wide" Rules of Origin as fixed costs, and they should not be underestimated. For the case of NAFTA, Anson et al. (2005) estimate that whereas the compliance costs are on average 6% in ad valorem terms, administrative costs amount to as much as 47% of the preferential margin.

Given these cost structure, the Melitz framework proves ideal to model RoO's. A firm that wants to avoid paying the tariff (also modelled as a variable cost), would have to be efficient enough to cover fixed cost aspect of the rule of origin and then be able to trade at the lower variable cost implied by the product specific rule of origin (vis-à-vis the tariff).

3 Theoretical Model

In this section I present a simple model of the decision facing heterogeneous firms to serve the foreign market either by becoming an exporter or by operating as a GVC. In either case they have the option to avoid paying the tariff by complying with the RoO's. The model incorporates increasing returns to scale, monopolistic competition, and the use of labour as the only factor of production, as in Krugman

(1980), and firms with heterogeneous marginal costs facing a fixed cost to enter each market, as in Melitz (2003).

Basic Set Up

Demand

The representative consumer has a two tier utility function over a homogeneous good, z, and a continuum of differentiated goods, $q(i)$. The upper tier has Cobb-Douglas preferences determining the division of income between these goods, and the lower tier has CES preferences over the continuum of varieties, with an elasticity of substitution $\sigma > 1$.

$$U = z^{1-\mu} Q^{\mu} \text{ ,} where \;\; Q = (\int_{i=0}^{n} q(i)^{\frac{\sigma-1}{\sigma}} di)^{\frac{\sigma}{\sigma-1}}$$

A fraction of income, $1-\mu$, is spent on the homogeneous good, and a fraction, μ, is spent on the differentiated goods. The demand function for a particular variety of the differentiated good is then:

$$q(i) = (\frac{p(i)}{P})^{-\sigma} \frac{E}{P} \text{ ,} with \;\; P = (\int_{i=0}^{n^i} p(i)^{1-\sigma} di)^{\frac{1}{1-\sigma}}$$

where P is the typical CES price index, and $E = \mu W$ is the expenditure on the differentiated goods.

Supply

Labour is the only factor of production and it is supplied inelastically in a competitive market. The homogeneous good, z, is produced under perfect competition and constant returns to scale. It takes a unit of effective labour to produce z. Competition implies price equals marginal cost and we take z as our numeraire, rendering $p_z = w = 1$. As long as the homogeneous good is produced in every country and freely traded, the cost of producing it will be the same in every country, and so will the wages.

The market structure for the differentiated good is monopolistic competition á la Melitz. Every entrant has to pay a sunk entry cost of F_I. Once this cost is paid, the firm draws a labour per unit coefficient, a, from a distribution $G(a)$, and upon observing this decides whether or not to produce. Productivity remains fixed after entry, but firms face a constant probability of death, δ according to a Poisson distribution.

After observing their productivity coefficient, remaining firms will decide how to produce. Firms utilising only regional inputs and selling domestically will face a constant variable cost, a, dependent on their productivity, and a fixed overhead labour cost, F_D, to serve the domestic market.

In a divergence from Melitz, firms that decide to use foreign inputs will face an additional iceberg trade cost, $\tau = 1 + t$, for getting these inputs shipped, and an additional fixed cost of F_G for establishing a channel to import intermediates. Foreign inputs, however, are assumed to be cheaper than their regional counterparts by a factor of $1 + \omega$, where ω represents a price wedge for the cheaper inputs. In our baseline model we will assume that paying the cost for importing intermediates and only serving the domestic market is not a dominant strategy for a firm. This strategy is dominated a firm choosing to also export. This allows us to focus the analysis on firms serving the foreign market. We will relax this assumption in the appendix.

Serving the Foreign Market

If a firm that utilises regional inputs decides to export, it will bear an additional fixed cost of F_X, which we interpret as the cost of forming a distribution network in a foreign country, as well as a marginal cost which is augmented by the ad valorem tariff, $\tau \equiv 1 + t$ of the product.

Continuing with the divergence from Melitz, if a firm that uses foreign inputs decides to export (we refer to these as Global Value Chains), it will bear an additional fixed cost of ηF_G where η is the number of stages of production (representing the number of times the product crosses the border before reaching the final consumer), and a variable cost which is augmented by a factor of $\eta^{\alpha/1-\sigma}$, where $\alpha \in (0, 1)$ is the coefficient of fragmentation (representing the diminishing returns from the fragmentation of the production process).

An exporting firm may decide to export under free trade, which would allow it to avoid paying the ad-valorem tariffs, $1 + t$. To export under free trade, however, the firm will have to comply with the rule of origin, $1 + R$. R represents the additional cost that the firm would have to undergo in its production process in order for its goods to confer origin and therefore be eligible for preferential access. Additionally the firm would have to pay a fixed cost of Γ which represents the costs for certification and verification of origin of the merchandise.

Similarly, a Global Value Chain may decide to operate under free trade. This would allow it to avoid paying the multiple tariffs in its production process, but it will face a more complicated process to comply with the rules of origin. It will also have to pay the fixed cost for the certification and verification of origin.

3.1 The Firm's Problem

Given monopolistic competition and CES preferences, the profit maximising price will be a constant mark up, $\frac{\sigma}{\sigma-1}$, over marginal cost for each firm. The profits of firms will depend both on their marginal costs and on their mode of globalisation. The operating profits for a firm only serving the domestic market are therefore be:

$$\pi_D = \frac{a^{1-\sigma}}{\Delta}\left(\frac{E}{n\sigma\delta}\right) - F_D$$

where $\Delta = [(1 - 1/\sigma)P\ ]^{1-\sigma} n^{-1}$ can be interpreted as a weighted average of the marginal costs of all active firms.

A firm that decides to export will have to pay the ad valorem tariff, $1 + t$, as well as the fixed cost for entering the foreign market, F_X. The additional operating profit for a firm that exports is therefore

$$\pi_X = \frac{\phi a^{1-\sigma}}{\Delta}\left(\frac{E}{n\sigma\delta}\right) - F_X \quad (1)$$

where $0 \leq \phi \equiv (1+t)^{1-\sigma} \leq 1$.

A firm that decides to operate as a Global Value Chain will have to pay multiple tariffs, but it will have access to cheaper inputs from abroad. It will also have to pay a fixed cost of ηF_G for establishing a channel to import intermediates. The additional operating profit for a Global Value Chain is therefore

$$\pi_G = \frac{\phi_G a^{1-\sigma}}{\Delta}\left(\frac{E}{n\sigma\delta}\right) - F_X - \eta F_G \quad (2)$$

where $\phi_G \equiv \eta^{\alpha}[(\frac{1+t}{1+\omega})^{1-\sigma}]$, η is the number of stages of production, and ω the price wedge from the access to cheaper inputs.

An exporting firm that decides to operate under Free Trade would not have to pay the ad valorem tariffs, so long as it complies with the Rules of Origin, $1 + R$. It will also have to pay the fixed cost for certification and verification of origin, Γ. The additional operating profit for an exporting firm that complies with the rules of origin is therefore

$$\pi_{X,R} = \frac{\rho a^{1-\sigma}}{\Delta}(\frac{E}{n\sigma\delta}) - F_X - \Gamma \tag{3}$$

where $0 \leq \rho \equiv (1+R)^{1-\sigma} \leq 1$.

A Global Value Chain may also decide to operate under Free Trade. It would not have to pay the multiple tariffs in its production process, but it will face a more complicated process to comply with the rules of origin, $1 + R$. It will also have to pay the fixed cost for certificaiton and verification of origin, Γ. The additional operating profit for a Global Value Chain that complies with the rules of origin is therefore

$$\pi_{G,R} = \frac{\rho_G a^{1-\sigma}}{\Delta}(\frac{E}{n\sigma\delta}) - F_X - \eta F_G - \Gamma \tag{4}$$

where $\rho_G \equiv \eta^{\alpha}[(\frac{1+R}{1+\omega})^{1-\sigma}]$.

Given the different costs faced by the firms and the different modes of globalisation, we will assume the following relationship regarding productivity levels.

$$a_{G,R} < a_G < a_{X,R} < a_X < a_D \tag{I}$$

Similarly, we assume the following relationship regarding fixed costs:

$$\frac{F_X+\eta F_G+\Gamma}{\rho_G} > \frac{F_X+\eta F_G}{\phi_G} > \frac{F_X+\Gamma}{\rho} > \frac{F_X}{\phi} > F_D \tag{II}$$

For the ensuing analysis, it would be convenient to briefly discuss the logic behind the regularity conditions we have imposed[2].

In order for a firm to find complying with RoO attractive, the marginal cost for complying with the rule must be less than the ad valorem tariff, $1 + R < 1 + t$. We therefore assume that:

$$\rho > \phi \quad \text{(III)}$$

In order for an exporting firm to consider becoming a GVC, the imported inputs must be sufficiently cheap to make it profitable to pay the tariff on them, $\frac{1+t}{1+\omega} < 1$, resulting in:

$$\phi_G > \phi \quad \text{(IV)}$$

Applying this same logic, we find an equivalent relationship between the RoO compliance cost for an exporter and that of a GVC. That is:

$$\rho_G > \rho \quad \text{(V)}$$

Finally, a Global Value Chain will find it attractive to comply with origin it its compliance cost is less than the ad valorem tariffs. So

$$\rho_G > \phi_G \quad \text{(VI)}$$

We therefore have the following additional operating profits for firms serving the foreign market:

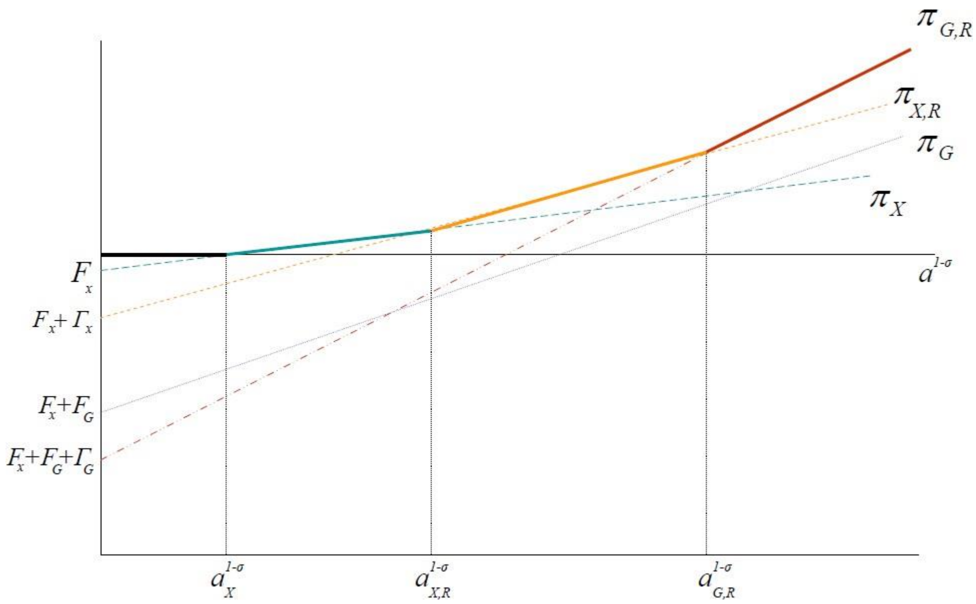
Table 3.1: Objective functions for Exporters and GVC's with and without compliance

	Not complying with RoO	**Complying with RoO**
Exporters	$\pi_X = \frac{\phi a^{1-\sigma}}{\Delta}(\frac{E}{n\sigma\delta}) - F_X$	$\pi_{X,R} = \frac{\rho a^{1-\sigma}}{\Delta}(\frac{E}{n\sigma\delta}) - F_X - \Gamma$
GVC	$\pi_G = \frac{\phi_G a^{1-\sigma}}{\Delta}(\frac{E}{n\sigma\delta}) - F_X - \eta F_G$	$\pi_{G,R} = \frac{\rho_G a^{1-\sigma}}{\Delta}(\frac{E}{n\sigma\delta}) - F_X - \eta F_G - \Gamma$

These profit functions are depicted in the following picture:

[2]The derivations are included in the Appendix.

Fig. 3.1. Sketch of Profits in the Foreign Market (adapted from Bustos (2011))



The figure represents operating profits in the foreign market in the vertical axis and $a^{1-\sigma}$ in the horizontal axis. Since $\sigma > 1$, $a^{1-\sigma}$ increases monotonically with labour productivity, $1/a$. More productive firms are more profitable in all activities. In the figure we see the equilibrium that obtains when $a_G < a_{X,R}$, where $1/a_G$ is the level of productivity above which an exporting firm would find operating as a GVC profitable, and $1/a_{X,R}$ is the level of productivity above which an exporting firm would find complying with origin profitable.

Firms with productivity levels below $a_D^{1-\sigma}$ expect to have negative profits and therefore exit the market (not in the graph for clarity of exposition). Firms with productivity levels between $(a_D)^{1-\sigma} < (a_X)^{1-\sigma}$ only find it profitable to sell domestically. Firms with productivity levels that lie between $(a_X)^{1-\sigma} < (a_{X,R})^{1-\sigma}$ find it more profitable to export and pay the tariff level, than to comply with the rule of origin. Firms with productivity levels between $(a_{X,R})^{1-\sigma} < (a_{G,R})^{1-\sigma}$ find it more profitable to export and comply with the rule of origin than to source its inputs abroad by becoming a GVC. Firms with productivity levels above $(a_{G,R})^{1-\sigma}$ are Global Value Chains that find it profitable to comply with the rules of origin, in order to avoid paying multiple tariffs.

Finally, we notice from the diagram that being a Global Value Chain and paying for the multiple tariffs is a strategy always dominated by being a Global Value

Chain and complying with the Rules of Origin. The equilibrium in this model is illustrated by the upper envelope in the figure. We present the formal proof of the equilibrium in Section 7. I focus on the particular case of $a_G < a_{X,R}$ given the nature of the trade environment today: consider Factory North America, Factory Europe, and Factory Asia which largely operate under NAFTA, EEC Treaty and ASEAN rules, respectively. Focusing on this case, will also allow us to explore the effects of new RoO's under USMCA, or the UK agreements negotiated post-Brexit. The opposite case, $a_G > a_{X,R}$, would result in an equilibrium where most GVC's do not operate within FTA's and would be less interesting for our study.

4 Equilibrium Conditions and Model Tractability

4.1 Timing and Zero Profit Conditions

After paying the sunk cost of F_I and finding out their labour coefficient, a, the firm will decide whether to exit the market or to operate.

A firm will find it profitable to produce if it can expect positive profits. Firms will be willing to enter the market up to the point where there are no more profits to be expected in that market. The least productive firms, those with productivity levels below $(a_D)^{1-\sigma}$, expect negative profits and therefore exit the market. Firms with productivity levels above $(a_D)^{1-\sigma}$ will have positive operating profits domestically. The cutoff for exiting the market is therefore:

$$a_D = \left(\frac{F_D \Delta n \sigma \delta}{E}\right)^{\frac{1}{1-\sigma}} \tag{5}$$

A firm will only decide to serve the foreign market if its additional profits from selling in that market are non-negative. Its zero profit condition will therefore be (in terms of firms actually in operation):

$$\frac{a_X}{a_D} = \left(\frac{F_X}{F_D \phi}\right)^{\frac{1}{1-\sigma}} \tag{6}$$

The marginal firm complying with Rules of Origin will be such firm that is indifferent between exporting and paying the tariff, and exporting by complying with the rules and not pay the tariff, $\pi_X = \pi_{X,R}$. Its zero profit condition will therefore be:

$$\frac{a_{X,R}}{a_D} = \left(\frac{\Gamma}{F_D(\rho-\phi)}\right)^{\frac{1}{1-\sigma}} \tag{7}$$

The Marginal Global Value Chain will be such that it is indifferent between exporting and becoming a Global Value Chain, $\pi_{X,R} = \pi_{G,R}$. Its zero profit condition will therefore be determined by:

$$\frac{a_{G,R}}{a_D} = \left(\frac{\eta F_G}{F_D(\rho_G-\rho)}\right)^{\frac{1}{1-\sigma}} \tag{8}$$

4.2 Industry Equilibrium

In order to determine the Free Entry Condition, we can take advantage of the fact that we are dealing with steady states, and so the distribution of a's in the market will be equivalent to the likelihood of getting a "winner" (a firm with a labour coefficient efficient enough to operate). The Free Entry Condition will then be the level at which the ex ante expected profit of the firm equals its expected cost.

We then have that the ex ante expected value of a winner must equal its average operating profit earned in the market which is

$$\frac{E}{\sigma n \delta}$$

Only firms with $a < a_D$ will find it worthwhile to operate, so the ex ante expected fixed cost of getting a winner is[3]

$$\bar{F} = F_D + F_X\frac{G(a_X)}{G(a_D)} + \Gamma\frac{G(a_{X,R})}{G(a_D)} + \eta F_G\frac{G(a_{G,R})}{G(a_D)} + F_I\frac{1}{G(a_D)} \tag{9}$$

The fist term on the right hand side is the fixed cost for selling in the domestic market (a cost every operating firm will pay). The second term includes the fixed cost for exporting, but since only certain firms will export, this is multiplied by

[3] Equivalently this could express as $\bar{F} = F_D + F_X\frac{G(a_X)-G(a_{X,R})}{G(a_D)} + (\Gamma + F_X)\frac{G(a_{X,R})-G(a_{G,R})}{G(a_D)} + (F_X + \eta F_G + \Gamma)\frac{G(a_{G,R})}{G(a_D)} + F_I\frac{1}{G(a_D)}$, coinciding with the fixed costs associated with each type of firm

$G(a_X)/G(a_D)$, the probability of being an exporter conditional on being a "winner". The third and fourth terms are the fixed cost for being a complying firm and the fixed cost for being a GVC multiplied respectively by its conditional probabilities. The last term reflects the ex ante development cost of getting a winner: the sunk entry cost, F_I times the inverse probability of getting a winner.

We then have that for the free entry condition, the expected value of a winner must match the expected fixed cost:

$$\frac{E}{n\sigma\delta} - \bar{F} = 0 \tag{10}$$

In order to find a tractable solution, we employ the Pareto Distribution in our model, and describe it in the next section.

4.3 Closed Form Solution and Model Tractability

We now use the Pareto distribution as a functional form for $G(a)$ in order to obtain a closed form solution for our model. Conveniently, the fractals nature of the Pareto distribution implies that a continuous slice of the Pareto distribution is itself a Pareto distribution with the same shape parameter. We then have the following CDF[4] :

$$G(a) = (\frac{a}{a_0})^k, \quad 0 \leq a \leq a_0$$

Our Price Index, Δ, becomes

$$\Delta = \int_0^{a_D} a^{1-\sigma} dG(a|a_D) + \phi \int_{a_{X,R}}^{a_X} a^{1-\sigma} dG(a|a_D)$$
$$+\rho \int_{a_{G,R}}^{a_{X,R}} a^{1-\sigma} dG(a|a_D) + \rho_G \int_0^{a_{G,R}} a^{1-\sigma} dG(a|a_D)$$

$$\Rightarrow \Delta = \frac{a_D^{1-\sigma}(1+\bar{\Omega})}{1-1/\beta} \tag{11}$$

Where we have introduced the zero profit conditions from the previous subsection and defined:

[4]The derivations are included in the Appendix

$$\bar{\Omega} = \Omega + \Omega_{X,R} + \Omega_{G,R}, \quad \Omega = \phi^{\beta}(\frac{F_X}{F_D})^{1-\beta}, \quad \beta = \frac{k}{\sigma-1} > 1,$$

$$\Omega_{X,R} = (\rho - \phi)^{\beta}(\frac{\Gamma}{F_D})^{1-\beta}, \quad \Omega_{G,R} = (\rho_G - \rho)^{\beta}(\frac{\eta F_G}{F_D})^{1-\beta}$$

The Ω terms above represent the incentives to operate by each type of firm and will be analysed in the next section. From the price index (11) free entry condition (10), and from the cutoff condition (5) we can express our ex ante expected fixed cost as:

$$\bar{F} = \frac{F_D(1+\bar{\Omega})}{1-1/\beta} \quad (12)$$

The only source of current income in this model is labour, $E = L$, and so we can express our closed form solution for the number of entrants as:

$$n = \frac{L(\beta-1)}{\beta F_D(1+\bar{\Omega})\sigma\delta} \quad (13)$$

In order to obtain the cutoff conditions for our different firms, we first introduce the respective CDF's into the the free entry condition:

$$\bar{F} = F_D + F_X\frac{G(a_X)-G(a_{X,R})}{G(a_D)} + (\Gamma + F_X)\frac{G(a_{X,R})-G(a_{G,R})}{G(a_D)}$$
$$+(F_X + \eta F_G + \Gamma)\frac{G(a_{G,R})}{G(a_D)} + F_I\frac{1}{G(a_D)}$$

The cutoff conditions for our firms- a_D, a_x, $a_{X,R}$, and $a_{G,R}$- are therefore:

$$a_D = a_0(\frac{(\beta-1)F_I}{(1+\bar{\Omega})F_D})^{1/k} \quad (14)$$

$$a_X = a_0(\frac{\Omega(\beta-1)F_I}{(1+\bar{\Omega})F_X})^{1/k} \quad (15)$$

$$a_{X,R} = a_0(\frac{\Omega_{X,R}(\beta-1)F_I}{(1+\bar{\Omega})\Gamma})^{1/k} \quad (16)$$

$$a_{G,R} = a_0(\frac{\Omega_{G,R}(\beta-1)F_I}{(1+\bar{\Omega})\eta F_G})^{1/k} \quad (17)$$

5 Incentives

The Ω variables presented above provide intuition useful for the rest of the analysis so we discuss them in turn. The variable Ω is interpreted by Baldwin & Forslid (2010) as an openness parameter which measures the protective effects of higher fixed and variable trade costs. We have that $\Omega = 0$ with sufficiently large tariffs, $1 + t$, or sufficiently large fixed trade costs F_X/F_D. And we have $\Omega = 1$ with zero tariffs and $F_X = F_D$. Therefore Ω represents the incentives a firm will have to export.

$$\Omega = \phi^{\beta}(\frac{F_X}{F_D})^{1-\beta}$$

In the same spirit, we can determine incentive parameters when analysing Rules of Origin and Global Value Chains.

Incentives to comply with the rule of origin

We interpret the term $\Omega_{X,R}$ as the incentives for a firm to comply with the rules of origin. Prior studies have found that utilisation rates are higher for products with a larger preference margin (the difference between the MFN rates and preferential rates), larger trade volumes, and less restrictive rules of origin (Anson et al. (2005); Olarreaga & Özden (2005), Özden & Sharma (2006), Cirera (2014)). Accordingly, this is the same behaviour exhibited by $\Omega_{X,R}$.

$$\Omega_{X,R} = (\rho - \phi)^{\beta}(\frac{\Gamma}{F_D})^{1-\beta}$$

$$\Omega_{X,R} = ((1+R)^{1-\sigma} - (1+t)^{1-\sigma})^{\beta}(\frac{\Gamma}{F_D})^{1-\beta}$$

Notice that this term will increase the larger the preference margin is, $1+t > 1+R$. On the contrary, the term will be zero if the preference margin is zero (recall the assumption the RoO cannot be higher than the tariff). This term will also be zero if the RoO is so restrictive that it offsets the savings in tariffs, $1 = R$, or if the administrative, or certification, verification costs to comply with the rule, Γ, are sufficiently large. We confirm these observations with the following comparative statistics:

$$\frac{\partial \Omega_{X,R}}{\partial t} = \beta \frac{(\sigma-1)}{\rho-\phi}(1+t)^{-\sigma}\Omega_{X,R} > 0$$

Notice here the incentive to comply with the rule of origin increases the larger the tariff (and by consequence the larger the preference margin).

$$\frac{\partial \Omega_{X,R}}{\partial R} = \beta \frac{(1-\sigma)}{\rho-\phi}(1+R)^{-\sigma}\Omega_{X,R} < 0$$

The incentive to comply with the rule of origin increases the less restrictive the rule of origin is.

$$\frac{\partial \Omega_{X,R}}{\partial \Gamma} = (1-\beta)\Gamma^{-1}\Omega_{X,R} < 0$$

The incentive to comply with the rule of origin increases the less costly its certification and verification process is.

Incentives to become a GVC

We interpret the term $\Omega_{G,R}$ as the incentives to become a Global Value Chain[5]. We expect that a firm would be more likely to operate as a GVC the cheaper the foreign intermediate inputs are, the easier it can establish a channel to import such inputs, and the laxer the rules of origin. This is the behaviour that $\Omega_{G,R}$ exhibits.

$$\Omega_{G,R} = (\rho_G - \rho)^{\beta}\left(\frac{\eta F_G}{F_D}\right)^{1-\beta}$$

$$\Omega_{G,R} = \left(\eta^{\alpha}\left(\frac{1+R}{1+\omega}\right)^{1-\sigma} - (1+R)^{1-\sigma}\right)^{\beta}\left(\frac{\eta F_G}{F_D}\right)^{1-\beta}$$

We notice that this term will be zero if the process for complying with the rules of origin, R is sufficiently restrictive. This term will be zero if the cost for establishing a channel to import intermediates, F_G is sufficiently large. This term will increase the cheaper the foreign intermediate inputs are, ω. This term will first increase and then decrease as the number of stages of production, η, increases. We confirm these observations with the following comparative statics:

$$\frac{\partial \Omega_{G,R}}{\partial F_G} = (1-\beta)(F_G)^{-1}\Omega_{G,R} < 0$$

The incentive to become a GVC will increase the smaller the cost for becoming a GVC (establishing a channel to import intermediates)

[5]in particular for the marginal firm, which would be a Rule of Origin complying exporter

$$\frac{\partial \Omega_{G,R}}{\partial \omega} = \beta(\rho_G - \rho)^{-1}\rho_G \frac{(\sigma-1)}{(1+\omega)}\Omega_{G,R} \ > 0$$

The incentive to become a GVC will increase the cheaper the foreign intermediate inputs are.

$$\frac{\partial \Omega_{G,R}}{\partial R} = \beta(1-\sigma)(1+R)^{-1}\Omega_{G,R} \ < 0$$

The incentive to become a GVC will increase the less restrictive the rules of origin are

$$\frac{\partial \Omega_{G,R}}{\partial \eta} = \underbrace{\beta(\rho_G - \rho)^{-1}\alpha\eta^{-1}\rho_G\Omega_{G,R}}_{>0} + \underbrace{(1-\beta)\eta^{-1}\Omega_{G,R}}_{<0}$$

The sign of the last equation is ambiguous. This is because the incentives to become a GVC first increases by having access to cheaper inputs, but later starts to decrease due to the decreasing gains from fragmentation. This decreasing gains from fragmentation can be due to the increasing costs of monitoring and coordinating workers and production the more stages are conducted abroad. In section 8 we endogenise this variable and find the optimal number of stages of productions given the trade off between specialisation gains and coordination costs.

6 Equilibrium

The model we have described so far, and which is depicted in figure 3.1, requires a particular ordering of the types of firms. Namely, our model predicts that being a Global Value Chain (paying the multiple tariffs) is always a strategy dominated by being a Global Value Chain that confers origin.

For this equilibrium to be be true we are requires to prove the following:

1. If an exporting firm firm finds conferring origin profitable, then a Global Value Chain will necessarily find conferring origin profitable.

2. If upgrading to a Global Value Chain is not profitable for an origin conferring exporter, operating as a Global Value Chain will not be profitable for a non-complying exporter.

1: If an exporting firm firm finds conferring origin profitable, then a Global Value Chain will necessarily find conferring origin profitable. That is:

$$\pi_{X,R} > \pi_X \Rightarrow \pi_{G,R} > \pi_G$$

Proof

$$\pi_{X,R} > \pi_X \Rightarrow \frac{(\rho-\phi)a^{1-\sigma}}{\Delta}(\frac{E}{n\sigma\delta}) > \Gamma \Rightarrow \frac{(\rho_G-\phi_G)a^{1-\sigma}}{\Delta}(\frac{E}{n\sigma\delta}) > \Gamma \Rightarrow \pi_{G,R} > \pi_G$$

For this to hold, we require that $(\rho_G - \phi_G) > \rho - \phi$:

$$\rho_G - \phi_G = \eta^{\alpha}\,(\frac{1}{1+\omega})^{1-\sigma}[(1+R)^{1-\sigma} - (1+t)^{1-\sigma}] > (1+R)^{1-\sigma} - (1+t)^{1-\sigma} = \rho - \phi$$

The inequality holds since $\alpha \in (0,1)$ and $\eta \in (1,\infty)$.

2: If upgrading to a Global Value Chain is not profitable for an origin conferring exporter, operating as a Global Value Chain will not be profitable for a non-complying exporter. That is:

$$\pi_{X,R} > \pi_X \Rightarrow \pi_{G,R} > \pi_G$$

Proof

$$\pi_{X,R} > \pi_X \Rightarrow \frac{(\rho-\phi)a^{1-\sigma}}{\Delta}(\frac{E}{n\sigma\delta}) > \Gamma \Rightarrow \frac{(\rho_G-\phi_G)a^{1-\sigma}}{\Delta}(\frac{E}{n\sigma\delta}) > \Gamma \Rightarrow \pi_{G,R} > \pi_G$$

Or equivalently,

$$\pi_{X,R} > \pi_{G,R} \Rightarrow \frac{(\rho_G-\rho)a^{1-\sigma}}{\Delta}(\frac{E}{n\sigma\delta}) < \eta F_G \quad \Rightarrow$$
$$\frac{(\phi_G-\phi)a^{1-\sigma}}{\Delta}(\frac{E}{n\sigma\delta}) < \eta F_G \quad \Rightarrow \pi_X > \pi_G$$

For this to hold, we require that $(\phi_G - \phi) < (\rho_G - \rho)$.

$$(\phi_G - \phi) < (\rho_G - \rho)$$
$$\Rightarrow \rho_G - \phi_G > \rho - \phi$$

Which we have proven earlier to be the case.

7 Stages of Production

The number of stages of production, η, has been regarded as a fixed parameter throughout the paper to simplify the analysis. In this section we will treat η as an endogenous variable, the firm will decide the number of stages of production it will operate. We first find the optimal number of stages of production in the model. A firm would face a trade-off between specialisation gains and coordination costs. The variable α represents the diminishing returns from the fragmentation of the production process. Offshoring would be attractive given the cheaper inputs from abroad. However the more stages are performed abroad, the costlier it is to monitor and coordinate workers and processes. Then we show that the optimal number of stages of productions is affected negatively the more restrictive the rules of origin are, but it is affected positively the cheaper the foreign inputs.

The operating profits for a Global Value Chain that complies with the rules of origin are the following:

$$\pi_{G,R} = \frac{\rho_G a^{1-\sigma}}{\Delta}(\frac{E}{n\sigma\delta}) - F_X - \eta F_G - \Gamma$$

$$\pi_{G,R} = \eta^{\alpha} \left(\frac{1+R}{1+\omega}\right)^{1-\sigma} \frac{a^{1-\sigma}}{\Delta} \left(\frac{E}{n\sigma\delta}\right) - F_X - \eta F_G - \Gamma$$

To find the optimal level of stages of production we obtain the First Order Condition:

$$\frac{\partial \pi_{G,R}}{\partial \eta} = \alpha\, \eta^{\alpha-1} \left(\frac{1+R}{1+\omega}\right)^{1-\sigma} \frac{a^{1-\sigma}}{\Delta} \left(\frac{E}{n\sigma\delta}\right) - F_G = 0$$

$$\Rightarrow \eta^{*} = \left[\frac{\alpha}{F_G} \frac{a^{1-\sigma}}{\Delta} \left(\frac{E}{n\sigma\delta}\right) \left(\frac{1+R}{1+\omega}\right)^{1-\sigma}\right]^{\frac{1}{1-\alpha}}$$

With Second Order Condition:

$$\frac{\partial^2 \pi_{G,R}}{\partial \eta^2} = \alpha(\alpha-1)\, \eta^{\alpha-2} \left(\frac{1+R}{1+\omega}\right)^{1-\sigma} \frac{a^{1-\sigma}}{\Delta} \left(\frac{E}{n\sigma\delta}\right) < 0$$

Therefore this is indeed a Maximum.

Regarding the Optimal number of stages of production,

$$\eta^{*} = \left[\frac{\alpha}{F_G} \frac{a^{1-\sigma}}{\Delta} \left(\frac{E}{n\sigma\delta}\right) \left(\frac{1+R}{1+\omega}\right)^{1-\sigma}\right]^{\frac{1}{1-\alpha}}$$

We notice that the optimal number of stages decreases as the restrictiveness of the rule of origin increases (R). The optimal number of stages increases the cheaper the imported inputs are (ω). The optimal number of stages of production decreases the higher the fixed cost of establishing the Global Value Chain (F_G). We confirm this with the following comparative statics:

$$\frac{\partial \eta^{*}}{\partial R} = \frac{1-\sigma}{1-\alpha} (1+R)^{-1}\, \eta \; < 0$$

The optimal number of stages of production increases the less restrictive the rules of origin are.

$$\frac{\partial \eta^*}{\partial \omega} = \frac{\sigma - 1}{1 - \alpha}(1 + \omega)^{-1}\,\eta \ > 0$$

The optimal number of stages of production increases the cheaper the foreign intermediate inputs are.

$$\frac{\partial \eta^*}{\partial F_G} = \frac{1}{\alpha - 1}(F_G)^{-1}\,\eta \ < 0$$

The optimal number of stages of production increases the less expensive the cost for establishing the Global Value Chain.

8 Comparative Analysis

A final consideration we explore in this study is the question of whether complying with rules of origin is more profitable to a Global Value Chain or to a normal exporter. As it has been discussed earlier, for a Global Value Chain the process of complying with rules of origin is more costly given that there are, by definition, several stages involved. As we will demonstrate in this section, however, the benefits of complying will also be larger for a Global Value Chain.

In the first part we carry out this exercise using comparative statics straightforwardly. Afterwards we present the elasticities depicting how sensitive are profits to compliance of the rules of origin, both for the normal exporter and the Global Value Chain.

From both exercises, we can reach the conclusion that a Global Value Chain has higher incentives to comply with the RoO than a normal exporter.

For an exporter we have that:

$$\pi_{X,R} = \frac{\rho a^{1-\sigma}}{\Delta}\left(\frac{E}{n\sigma\delta}\right) - F_X - \Gamma = (1+R)^{1-\sigma}\,\frac{a^{1-\sigma}}{\Delta}\left(\frac{E}{n\sigma\delta}\right) - F_X - \Gamma$$

$$\frac{\partial \pi_{X,R}}{\partial R} = (1-\sigma)(1+R)^{-1}\,\frac{\rho a^{1-\sigma}}{\Delta}\left(\frac{E}{n\sigma\delta}\right)$$

For a Global Value Chain we have that:

$$\pi_{G,R} = \frac{\rho_G a^{1-\sigma}}{\Delta}\left(\frac{E}{n\sigma\delta}\right) - F_X - \eta F_G - \Gamma = \eta^{\alpha}\left(\frac{1+R}{1+\omega}\right)^{1-\sigma}\frac{a^{1-\sigma}}{\Delta}\left(\frac{E}{n\sigma\delta}\right) - F_X - \eta F_G - \Gamma$$

$$\frac{\partial \pi_{G,R}}{\partial R} = (1-\sigma)(1+R)^{-1}\,\frac{\rho_G a^{1-\sigma}}{\Delta}\left(\frac{E}{n\sigma\delta}\right)$$

Recall from our regularity conditions on section 3.4 that $\rho_G > \rho$. Therefore,

$$\left|\frac{\partial \pi_{X,R}}{\partial R}\right| < \left|\frac{\partial \pi_{G,R}}{\partial R}\right|$$

Elasticities

For an exporter we have that:

$$\varepsilon^{R}_{\pi_{x,r}} = \frac{\partial \pi_{X,R}}{\partial R}\,\frac{R}{\pi_{X,R}} = (1-\sigma)\,\frac{R}{1+R}\left(\frac{\frac{\rho a^{1-\sigma}}{\Delta}\left(\frac{E}{n\sigma\delta}\right)}{\frac{\rho a^{1-\sigma}}{\Delta}\left(\frac{E}{n\sigma\delta}\right) - F_X - \Gamma}\right)$$

$$= (1-\sigma)\,\frac{R}{1+R}\left(\frac{\frac{a^{1-\sigma}}{\Delta}\left(\frac{E}{n\sigma\delta}\right)}{\frac{a^{1-\sigma}}{\Delta}\left(\frac{E}{n\sigma\delta}\right) - \frac{F_X+\Gamma}{\rho}}\right)$$

$$= (1-\sigma)\,\frac{R}{1+R}\left(1 - \frac{\frac{F_X+\Gamma}{\rho}}{\frac{a^{1-\sigma}}{\Delta}\left(\frac{E}{n\sigma\delta}\right)}\right)^{-1}$$

For an global value chain we have that:

$$\varepsilon^{R}_{\pi_{g,r}} = \frac{\partial \pi_{G,R}}{\partial R}\frac{R}{\pi_{G,R}} = (1-\sigma)\frac{R}{1+R}\left(\frac{\frac{\rho_G a^{1-\sigma}}{\Delta}(\frac{E}{n\sigma\delta})}{\frac{\rho_G a^{1-\sigma}}{\Delta}(\frac{E}{n\sigma\delta}) - F_X - \eta F_G - \Gamma}\right)$$

$$= (1-\sigma)\frac{R}{1+R}\left(\frac{\frac{a^{1-\sigma}}{\Delta}(\frac{E}{n\sigma\delta})}{\frac{a^{1-\sigma}}{\Delta}(\frac{E}{n\sigma\delta}) - \frac{F_X + \eta F_G + \Gamma}{\rho_G}}\right)$$

$$= (1-\sigma)\frac{R}{1+R}\left(1 - \frac{\frac{F_X+\eta F_G+\Gamma}{\rho_G}}{\frac{a^{1-\sigma}}{\Delta}(\frac{E}{n\sigma\delta})}\right)^{-1}$$

Recall from our assumptions on section 3.3 that $\frac{F_X+\eta F_G+\Gamma}{\rho_G} > \frac{F_X+\Gamma}{\rho}$. Therefore,

$$\left|\varepsilon^{R}_{\pi_{x,r}}\right| < \left|\varepsilon^{R}_{\pi_{g,r}}\right|$$

9 Concluding Remarks

Preferential Trade Agreements and Global Value Chains are prevalent features of the trade environment today. In this paper I present a theoretical framework to understand the important nexus that exists between the two of them. I employ a trade model of heterogeneous firms a la Melitz where a firm, depending on its productivity coefficient, decides to serve the foreign market either as an exporter or as a GVC. The firms also have the option to avoid paying the tariffs by complying with the RoO's. In the case of a GVC, with the product crossing the border multiple times before reaching the final consumer, the process can be much more complicated, but the rewards for complying with the RoO are also larger.

I then discuss the different incentives that a firm faces both to comply with the RoO's, and to operate as a GVC. I calculate what the optimal number of stages of production are for a GVC. I find that the optimal number of stages of production is negatively affected by more restrictive rules of origin, and it is positively affected by less expensive foreign intermediate inputs. Lastly, using elasticities, I show that the benefits for complying with the RoO will be larger for a Global Value Chain than for a normal exporter.

In future work, I plan to empirically test the model. This should be feasible with the use of recent highly detailed Global Supply Chain databases like the EORA Multi

Region Input-Output table, firm level data such as the Monthly Industrial Survey from the Mexican Institute of Statistics and Geography, and Product Specific Rules of Origin from the DESTA classification database of the World Bank.

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Appendices

9.1 Derivation of Closed Form Solution

We now use the Pareto distribution as a functional form for $G(a)$ in order to obtain a closed form solution for our model. Conveniently, the fractals nature of the Pareto distribution implies that a continuous slice of the Pareto distribution is itself a Pareto distribution with the same shape parameter. We then have the following CDF:

$$G(a) = (\frac{a}{a_0})^k, \quad 0 \leq a \leq a_0$$

so

$$dG(a) = \frac{ka^{k-1}}{a_0^k} da$$

Our Price Index, Δ, becomes

$$\Delta = \int_0^{a_D} a^{1-\sigma} dG(a|a_D) + \phi \int_{a_{X,R}}^{a_X} a^{1-\sigma} dG(a|a_D)$$
$$+\rho \int_{a_{G,R}}^{a_{X,R}} a^{1-\sigma} dG(a|a_D) + \rho_G \int_0^{a_{G,R}} a^{1-\sigma} dG(a|a_D)$$

$$\Delta = \int_0^{a_D} a^{1-\sigma} \frac{ka^{k-1}}{a_D^k} da + \phi \int_{a_{X,R}}^{a_X} a^{1-\sigma} \frac{ka^{k-1}}{a_D^k} da$$
$$+\rho \int_{a_{G,R}}^{a_{X,R}} a^{1-\sigma} \frac{ka^{k-1}}{a_D^k} da + \rho_G \int_0^{a_{G,R}} a^{1-\sigma} \frac{ka^{k-1}}{a_D^k} da$$

$$= \frac{ka_D^{1-\sigma}}{k-\sigma+1} [1 + \phi(\frac{a_X}{a_D})^{k-\sigma+1} + (\rho - \phi)(\frac{a_{X,R}}{a_D})^{k-\sigma+1} + (\rho_G - \rho)(\frac{a_{G,R}}{a_D})^{k-\sigma+1}]$$

$$= \frac{a_D^{1-\sigma}}{1-1/\beta} [1 + \phi^\beta (\frac{F_X}{F_D})^{1-\beta} + (\rho - \phi)^\beta (\frac{\Gamma}{F_D})^{1-\beta} + (\rho_G - \rho)^\beta (\frac{\eta F_G}{F_D})^{1-\beta}]$$

$$\Rightarrow \Delta = \frac{a_D^{1-\sigma}}{1-1/\beta} [1 + \Omega + \Omega_{X,R} + \Omega_{G,R}] = \frac{a_D^{1-\sigma}(1+\bar{\Omega})}{1-1/\beta}$$

Where we have defined

$$\Omega = \phi^\beta (\frac{F_X}{F_D})^{1-\beta}, \quad \beta = \frac{k}{\sigma-1} > 1,$$

$$\Omega_{X,R} = (\rho - \phi)^\beta (\frac{\Gamma}{F_D})^{1-\beta}, \quad \Omega_{G,R} = (\rho_G - \rho)^\beta (\frac{\eta F_G}{F_D})^{1-\beta}$$

$$\bar{\Omega} = \Omega + \Omega_{X,R} + \Omega_{G,R}$$

To obtain the ex ante expected fixed cost, we note that,

$$\frac{a_D^{1-\sigma}}{\Delta} = \frac{1-1/\beta}{1+\bar{\Omega}}$$

From the free entry condition (5), and from the cutoff condition (1) we can obtain

$$\bar{F} = \frac{F_D(1+\bar{\Omega})}{1-1/\beta}$$

The only source of current income in this model is labour, so:

$$E = L$$

We can now obtain closed form solutions for the number of entrants, n, and the cutoff conditions- a_D, a_X, $a_{X,R}$, and $a_{G,R}$. Note first that

$$\frac{1-1/\beta}{1+\bar{\Omega}}\left(\frac{E}{n\sigma\delta}\right) = F_D$$

$$\Rightarrow n = \frac{L(\beta-1)}{\beta F_D(1+\bar{\Omega})\sigma\delta}$$

From the free entry condition we have

$$\bar{F} = \frac{E}{\sigma n\delta} = \frac{F_D(1+\bar{\Omega})}{1-1/\beta}$$

$$\Rightarrow \bar{F} = F_D + F_X\frac{G(a_X)-G(a_{X,R})}{G(a_D)} + (\Gamma + F_X)\frac{G(a_{X,R})-G(a_{G,R})}{G(a_D)}$$
$$+(F_X + \eta F_G + \Gamma)\frac{G(a_{G,R})}{G(a_D)} + F_I\frac{1}{G(a_D)}$$

$$\Rightarrow \bar{F} = F_D + F_X\frac{G(a_X)}{G(a_D)} + \Gamma\frac{G(a_{X,R})}{G(a_D)} + \eta F_G\frac{G(a_{G,R})}{G(a_D)} + F_I\frac{1}{G(a_D)}$$

$$\Rightarrow \bar{F} = F_D + F_D\phi^\beta\left(\frac{F_X}{F_D}\right)^{1-\beta} + F_D(\rho-\phi)^\beta\left(\frac{\Gamma}{F_D}\right)^{1-\beta}$$
$$+F_D(\rho_G-\rho)^\beta\left(\frac{\eta F_G}{F_D}\right)^{1-\beta} + F_I\left(\frac{a_0}{a_D}\right)^k$$

$$\Rightarrow \bar{F} = F_D[1+\Omega+\Omega_{X,R}+\Omega_{G,R}] + F_I\left(\frac{a_0}{a_D}\right)^k$$

$$\Rightarrow \frac{\beta(1+\bar{\Omega})F_D}{\beta-1} = (1+\bar{\Omega})F_D + F_I\left(\frac{a_0}{a_D}\right)^k$$

$$\Rightarrow \frac{1+\bar{\Omega}}{\beta-1}F_D = F_I\left(\frac{a_0}{a_D}\right)^k$$

$$\Rightarrow a_D^k = a_0^k \frac{(\beta-1)F_I}{(1+\bar{\Omega})F_D}$$

The cutoff condition for domestic type firms is therefore:

$$\Rightarrow a_D = a_0 (\frac{(\beta-1)F_I}{(1+\bar{\Omega})F_D})^{1/k}$$

$$a_D^k = a_X^k (\frac{F_D \phi}{F_X})^{\frac{k}{1-\sigma}} = a_0^k \frac{(\beta-1)F_I}{(1+\bar{\Omega})F_D}$$

The cutoff condition for exporting firms is therefore:

$$\Rightarrow a_X = a_0 (\frac{\Omega(\beta-1)F_I}{(1+\bar{\Omega})F_X})^{1/k}$$

$$a_D^k = a_{X,R}^k (\frac{F_D(\rho-\phi)}{\Gamma})^{\frac{k}{1-\sigma}} = a_0^k \frac{(\beta-1)F_I}{(1+\bar{\Omega})F_D}$$

The cutoff condition for exporting firms that comply with origin is therefore:

$$\Rightarrow a_{X,R} = a_0 (\frac{\Omega_{X,R}(\beta-1)F_I}{(1+\bar{\Omega})\Gamma})^{1/k}$$

$$a_D^k = a_{G,R}^k (\frac{F_D(\rho_G-\rho)}{\eta F_G})^{\frac{k}{1-\sigma}} = a_0^k \frac{(\beta-1)F_I}{(1+\bar{\Omega})F_D}$$

The cutoff condition for Global Value Chains that comply with origin is therefore:

$$\Rightarrow a_{G,R} = a_0 (\frac{\Omega_{G,R}(\beta-1)F_I}{(1+\bar{\Omega})\eta F_G})^{1/k}$$

Regularity Conditions

It is convenient to briefly explain the logic behind the regularity conditions we have imposed before continuing with the analysis.

In order for a firm to find complying with Rules of Origin attractive, the marginal cost for complying with the rule must be less than the ad valorem tariff. We therefore have that,

$$1 + RoO < 1 + t$$
$$(1 + RoO)^{1-\sigma} > (1 + t)^{1-\sigma}$$
$$\Rightarrow \rho > \phi$$

In order for an exporting firm to consider becoming a Global Value Chain, the imported inputs must be sufficiently cheap to make it profitable to pay the tariff on them, $\frac{1+t}{1+\omega} < 1$, resulting in

$$\frac{1+t}{1+\omega} < 1$$
$$(\frac{1+t}{1+\omega})^{1-\sigma} > 1$$
$$\eta^{\alpha}\,(\frac{1+t}{1+\omega})^{1-\sigma} > 1$$
$$\Rightarrow \phi_G > 1$$
$$and$$
$$1 + t > 1$$
$$(1 + t)^{1-\sigma} < 1$$
$$\Rightarrow \phi < 1$$
$$\Rightarrow \phi_G > \phi$$

Recalling that $\eta \geq 1$ and $\alpha \in (0,1)$.

Applying this same logic, we find an equivalent relationship between the RoO compliance cost for an exporter and that of a Global Value Chain. That is:

$$\frac{1+RoO}{1+\omega} < 1$$
$$(\frac{1+RoO}{1+\omega})^{1-\sigma} > 1$$
$$\eta^{\alpha}\,(\frac{1+RoO}{1+\omega})^{1-\sigma} > 1$$
$$\Rightarrow \rho_G > 1$$
$$and$$
$$1 + RoO > 1$$
$$(1 + RoO)^{1-\sigma} < 1$$
$$\Rightarrow \rho < 1$$
$$\Rightarrow \rho_G > \rho$$

Finally, a Global Value Chain will find it attractive to comply with origin it its compliance cost is less than the ad valorem tariffs. So

$$\frac{1+RoO}{1+\omega} < \frac{1+t}{1+\omega}$$
$$(\frac{1+RoO}{1+\omega})^{1-\sigma} > (\frac{1+t}{1+\omega})^{1-\sigma}$$
$$\eta^{\alpha}\,(\frac{1+RoO}{1+\omega})^{1-\sigma} > \eta^{\alpha}\,(\frac{1+t}{1+\omega})^{1-\sigma}$$
$$\Rightarrow \rho_G > \phi_G$$