Essays on Global Value Chains, Policies and Inequality

by

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Dissertation submitted in partial fulfillment of
the requirements for the degree of Doctor
of Philosophy in Public Policy in the Graduate School
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2019

<u>ABSTRACT</u>

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Abstract

This thesis tackles development policy issues that arise when institutions have unequal power. It contributes to three fields: International Political Economy; Industrial Organization; Global Value Chain Analysis. Within this intersection I examine the institutional constraints to economic development created by global markets. I approach this question by mathematically modelling surplus distribution along Global Value Chains to simulate policy measures.

It shows that policy interventions can shift surplus shares from developing countries to advanced economies in presence of market power asymmetries. This surplus shift occurs with environmental and labor standards applied in the presence of partially-substitutable goods; and trade-based development policies . The models I develop in these papers provide a framework for further empirical investigation and policies that are better aligned with development goals.

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Chapter 1

Introduction

What do firms like Johnson and Johnson, Apple and Walmart have in common? They are among the ten most profitable firms globally. They also manage very complex supply chains. This is not uncommon. In a 2009 survey of the top 300 firms with profits over a billion dollars, the MIT Center for Transportation and Logistic found that the majority of their operations were conducted in countries other than the headquartered location (MIT, 2009). UNCTAD (2013) estimates that roughly 80% of global trade takes place within the production networks of multinational companies.

This thesis studies the distributional effects of policies enacted within Global Value Chains (GVCs). GVCs are international systems of production where the activities that lead a product from conception to final sale are divided among different actors often independent and geographically dispersed. They increasingly dominate the modern economy. Do policies redistribute resources among GVC participating firms in a way that is dependent on GVC structure?

I answer this question by mathematically modelling profit distribution along

GVCs with different structures. I compare the findings of the models with existing empirical literature. I use these models to simulate different types of policy interventions, such as trade-based development policies, competition policies, labor and environmental standards.

Results show that in presence of market power asymmetries such policies can shift the profit distribution in favor of large multinational buyers and to the detriment of suppliers. As such, these policies might exacerbate an already unequal profit distribution to the advantage of multinational companies. These studies imply that trade structure matter for policies, even for locally enforced ones. Any policy conditional on trade structure would replicate similar profit distribution. The models I develop in these papers effectively organize current empirical evidence on value captured within GVCs. They provide a framework for further empirical investigation and policies that are better aligned with development goals.

Concerns over inequality between countries are usually met with policies that increase trade openness, connect developing countries with foreign markets and provide the financial assistance to boost their international competitiveness (UNSDG10, 2017). Nevertheless, outcomes of these policies are very heterogeneous (Baldwin and Venables, 2015; Rodrik, 2016; Mudambi, 2008). Chapter 1 critically discusses trade-based development policies in a context where global trade is largely conducted within GVCs composed of oligopolistic firms. Using a recursive Cournot-based model, it clarifies under what conditions these policies benefit their target country.

I also consider under what conditions labor and environmental standards increase the vulnerability of producers in developing countries. This work connects to the significant literature on the international transmission of private regulation through the production networks of large enterprises (Vogel, 1995; Greenhill et al., 2009; Garcia-Johnson, 2000; Perkins and Neumayer, 2012; Prakash and Potoski, 2007, 2006; Poulsen et al., 2016). Chapter 2 provides a model, adapted from a monopolistic competition framework, of a multi-product retailer outsourcing production to upstream manufacturers. It investigates the cost distribution of upgrades in labor or environmental practices driven by consumer demands. It concludes that product substitutability interacted with the multi-product nature of downstream retailers plays an important part in shifting compliance costs on upstream producers. When products are highly substitutable, a multi-product retailer has more bargaining power and can shift labor and environmental compliance costs on to its suppliers.

Chapter 3 considers public regulation imposed on suppliers and retailers to protect labor and the environment. It compares public regulation imposed by the producing country on the supplier (imagine the government of Vietnam setting an environmental tax on garment producers, many of whom eventually sell their products to Walmart) and public regulation imposed by the consuming country on the retailer (imagine Walmart being taxed by the US if it imports products that embed an environmental externality). For all level of product substitutability, retailer compliance effort is the highest when the regulation is imposed on the retailer and the lowest when it is imposed on the supplier. Consumer driven standards are in the middle. These results suggest that fair compliance cost distribution between suppliers and retailers should be included in the discussion on how to achieve labor and environmental protection. In fact, this chapter shows that even when the benefits from regulation are global, the costs can be concentrated on low-income countries.

Chapter 2

Who Gets the Surplus in Global Value Chains? Development policy implications of value chain governance.

with Frederick Mayer and Alexander Pfaff

Major development agencies provide poor countries with support to jumpstart their involvement into Global Value Chains (GVCs). This paper investigates how the division of profits between producers involved in GVCs depends on horizontal competition (between firms at the same production stage) and vertical competition (between firms at different stages of production as driven by GVC governance). We employ a Cournot model adapted to multistage production to generate closed-form solutions of profit shares in a linear value chain. Results show that the interaction between horizontal and vertical competition impacts value captured by firms along GVCs. Vertical market power is a necessary but not sufficient condition to benefit from common development policies relative to other firms. We evaluate upstream and downstream changes in trade costs, horizontal competition, elasticity of demand and supply. We conclude that without considering the entire industry structure, trade-based development policies and competition policies might fail to meet their stated objectives and overwhelmingly benefit countries other than their targets.

2.1 Introduction

Inequality among countries is one of today's most salient development issues (Milanovic, 2015; Goldberg and Pavcnik, 2007; Antràs et al., 2017), precisely the 10th among the United Nations Sustainable Development Goals. This concern is met with policies that increase trade openness, connect developing countries with foreign markets and provide the financial assistance to boost their international competitiveness (UNSDG10, 2017). Nevertheless, outcomes of these policies see wide country heterogeneity (Baldwin and Venables, 2015; Rodrik, 2016; Mudambi, 2008). This paper critically discusses common policies for development in a context where global trade is largely conducted within Global Value Chains (GVCs) to assess under what conditions they benefit their target country.

Intermediate goods dominate trade patterns. Only 34% of trade is in final goods (Baldwin and Lopez-Gonzalez, 2015). UNCTAD (2013) estimated that 80% of global trade takes place within production the networks of large firms, with the vast majority involving independent market actors, thus forming GVCs. GVCs are international systems of production where the activities that lead a product from conception to the final consumers are divided among different actors often independent and geographically dispersed. A well-established framework in international development studies, GVC analysis has been adopted by major financial and development institutions.

There is a growing debate on trade-based development policies: if not coupled with policies that confer more bargaining power to manufacturing firms, welfare gains induced by trade will always concentrate in favor of large outsourcing firms (Mayer and Milberg, 2013). There is growing evidence, in fact, that most value is captured at key nodes of the value chain (Shih, 1996; Gereffi, 1994; Gereffi et al., 2005; Gereffi, 2005; Milberg, 2004) and those nodes are most often located the in advanced economies (Mudambi, 2008). Therefore, not only GVCs might create unequal outcomes among countries, but policies that facilitate trade in intermediates might exacerbate this unequal distribution.

This paper investigates under what conditions policies aiming at trade facilitation and industry competitiveness create unequal outcomes for the firms and countries participating in a GVC. We employ a recursive Cournot oligopoly/oligopsony model adapted to account for multistage production to provide a microeconomic analysis of profit distribution within a linear value chain[1]. The model is flexible for number of production stages and number of competing firms per stage. It yields closed-form solutions for quantity, prices and profits for each firm involved in the value chain. It generates a ranking of profit-shares as a function of horizontal competition (between direct competitors at the same stage of the value chain) and vertical competition (between firms at different stages of the value chain). The former is determined by the number of firms at each stage of the value chain as in a regular Cournot model. The latter stems from the amount of information intermediary firms have over market conditions (supply and demand): an intangible asset that defines GVC governance.

We set as Buyer Driven (BD) a value chain where downstream firms (close to consumers) have greater access to information over market conditions. In a Producer

[1]Or a supply chain of the 'snake' type in Baldwin and Venables (2013)

Driven (PD) model upstream intermediary firms (close to supply) enjoy that advantage. Profit distribution is skewed in favor of upstream suppliers in a PD chain and downstream retailers in a BD chain, keeping horizontal competition constant across intermediary stages. However, high shares of industry profits require both horizontal and vertical market power. These baseline results on profit distribution confirm traditional economic intuition and the work of Gereffi (1994, 1999a,b), Milberg and Winkler (2013) and the Smile Curve of Shih (1996), supporting subsequent policy results. We model changes in trade costs, horizontal competition, elasticity of demand and supply.

The model shows that the position of firms along the value chain affects the degree with which they benefit from these policies in ways that depend on GVC governance. In absolute terms all firms benefit at least weakly form a decrease in trade costs, as trade theory would predict. However, a drop in trade costs benefits firms relatively more if the change takes place downstream to them in a PD model and if it takes place upstream in a BD model. Intuitively, if you have two intermediary stages, both of them monopolies. One of those monopolists has more information, and hence bargaining power, than the other. Most of the extra surplus from decreasing trade costs flows towards the firm with the most bargaining power[2].

These results help explain the inconsistent outcomes of similar policies pursued in different contexts (Baldwin and Venables, 2015; Rodrik, 2016). Horizontal and vertical competition affect policy effectiveness: the benefits of economic development policies can spill over to countries other than their target under given market conditions. This line of thinking helps prioritizing some policies as a function of horizontal

[2]Similarly, an upstream increase in competition benefits firms relatively more than a downstream increase in a PD model, while the contrary is true for a BD model. A steeper demand benefits firms in a PD model, but not in a BD model. The contrary is true in the presence of a steeper supply.

and vertical competition. For instance, if the target country would benefit from inclusion in an BD industry, it would be more effective to decrease import duties on inputs rather than export duties on outputs. More of the associated increase in aggregate surplus would stick to the target country. Similarly, it would be more effective to search for competitive downstream buyer, rather than upstream suppliers, even though both options would make the country better off in absolute terms. The contrary would be true with a value chain dominated by upstream firms. When countries have limited resources this model provides a blueprint to rank proposed interventions.

Policy implications from a simple model should be taken with a grain of salt. Nevertheless, we validate this blueprint by showing in Section 2.5 that it simultaneously replicates some of the key results of the GVC literature, such as the surplus distribution in a PD and BD value chain according to Gereffi (1994, 1999a,b) and Milberg and Winkler (2013); the smile curve of Shih (1996); and traditional economic results. Importantly, organizing these different contributions in a mathematical framework allows policy counterfactuals.

This model has implications for thinking about the interplay between policies and changes in the economic environment. It explains why countries like China benefit from decreasing competition among domestic firms even if that decreases market efficiency. Additionally, in a world where economies are increasingly interconnected, but policies seem to be increasingly particularistic, it is important to understand the global redistribution of resources stemming from trade barriers among high-income countries, the effects of trade sanctions on countries other than the targeted ones, or the trade facilitations arrangements following China's Belt and Road Initiative. This changes will not only shift the distribution of gains from trade among countries, but also affect the impact and spillovers of development policies in a way this model predicts.

Future work needs to go into empirically validating the results and implications of this analytical framework as sound policy design can only be informed by a constant dialogue between theory and empirics. Empirical studies are always imperfect and context-specific, especially in studying GVC where the limited availability of fine-grained data hampers policy action. The analytical model provided effectively organizes the available evidence on value captured within GVCs and as such can provide insights on important policy questions. It can direct further empirical work, but also guide experimentation towards policies that are better aligned with development goals.

The paper is structured as follows: Section 1.2 provides a summary of the GVC and international trade literature at the basis to our analysis and to which this paper contributes. Section 2.3 provides an intuition of the formal model outlined in Section 1.4, that readers not interested in the mathematical derivation of our results can skip. Results on profit distribution among firms are provided in Section 2.5, where we also provide a comparison with the main contributions of our reference literature and then pass to the policy implications. Finally, Section 2.6 discusses the assumptions of the model, how they affect policy results while Section 1.7 concludes with the implications of the model and the work that needs to be done moving forward.

2.2 Previous Literature

A crucial elements of the GVC framework is the power dynamic between firms. GVC analysis assumes the presence of a chain of independent market actors where the input of one firm is the output of another. More importantly, this network usually crosses national borders and does not involve any formal control. Coordination mechanisms among firms, then, demand critical attention: what this literature defines chain governance. Gereffi (1994) argues that, by being the key actors that bring globally dispersed pieces of a business into an integrated whole, global buyers can exert a high degree of control over spatially dispersed production networks, even without direct ownership. They achieve that goal thanks to their knowledge of the whole production system, consumers' needs, concept design, branding and marketing (Morrison et al., 2008).

Coordination is thus exercised by lead firms located in crucial nodes of the value chain. These nodes display a centralization of assets, including a preferential access to market information (Bauman et al., 1982). Crucially, entry barriers create market power, and market power allows lead firms to coordinate a geographically disperse set of independent firms. Hence, you cannot coordinate GVCs without power asymmetries and these asymmetries drive differentials in profits among firms in the GVC.

Gereffi (1994, 1999a,b) describes two types of value chains: Producer Driven an Buyer Driven. The former is characterized by high levels of market power held by upstream firms. Think of medium/high technology industries, such as auto and aircraft, with market concentration in upstream segments thanks to valuable resources like intellectual property, superior design and the ability to commercialize new technologies (Gereffi et al., 2005; Gereffi, 2005). Instead, Buyer Driven chains are usually dominated by large retailers. These are brand named merchandizers and trading companies that organize decentralized production networks with subcontractors often located in third world countries. This structure is common in labor-intensive industries producing consumer goods, such as apparel, footwear, toys, and consumer electronics. Barriers to entry appear in downstream segments due to the necessary investments in marketing, advertising, branding and the fixed costs of extensive distribution logistics (Gereffi, 1994).

The ability of lead firms to generate and maintain these market power asymmetries allows them to coordinate their GVCs, but also to pressure input prices, increase production flexibility and insulate from demand shocks. Milberg (2004) posits that the power structure within GVCs affects the profits distribution among firms at different stages, independently of the value-added or sophistication of the task. When all actors along the chain have similar market power, markups tend to be uniform, while as power concentrates on some nodes of the chain, so do markups and profits.

Multiple case studies support these theories. Among the studies that document the effect of relative levels of competition at different stages of the value chain we can cite the case of the African coffee industry where consolidation at the downstream end of the chain translates into null or even negative profits for farmers (Fitter and Kaplinsky, 2001). A similar picture is painted in the African horticulture industry serving the European market. The European food retail sector is concentrated and the high quality standards of that market create large barriers to entry for African producers, leading to consolidation at the producers segment. This competitive structure compresses profit margins for importers, the relatively more competitive segment of the supply chain (Dolan and Humphrey, 2000).

The apparel sector, especially the fashion oriented one, is one of the classical examples of a buyer driven dynamic. Here, the great degree of consolidation at the retailer level, guarantees high mark-ups on domestically-produced and imported final products. A similar degree of consolidation at the textile production level squeezes garment producers' profits from both ends (Gereffi, 1994, 2002; Bair and Gereffi, 2001). Shin et al. (2012) show that component suppliers and retailers of electronics earn higher gross and net margins compared to contract manufacturers because of entry barriers into upstream and downstream segments.

Lack of knowledge about market characteristics has been documented in the Ugandan coffee industry. Fafchamps and Hill (2008) show that local traders, aware of global market dynamics, take advantage of robusta coffee growers' lack of price information. Similarly, opacity over market prices drive down Ecuadorian flower producers' profits that serve the New York market (Ziegler, 2007). Brand recognition also plays a part into it. For instance, IKEA leverages its brand name to obtain a larger share of the costs savings from innovative practices introduced by its suppliers (Ivarsson and Alvstam, 2010). In the consumer electronic sector, popular companies such as Apple, strong of their appeal to consumers, are able to squeeze the margins of suppliers (Sturgeon, 2002; Linden et al., 2007; Xing and Detert, 2010; Kraemer et al., 2011; Selden et al., 2013).

Entry barriers tend to be concentrated upstream and downstream the value chain. Value added and value captured follow the same pattern. The Smile Curve (Shih, 1996) describes value added along GVCs. It predicts that, following entry barriers, value added is going to be the highest at the input and output end of the value chain (design, R&D, marketing, branding, retail) and the lowest in the middle of the value chain (assembly, manufacturing, transportation). Shin et al. (2012) show that value captured for the electronics industry follows the same pattern.

These patterns have important development implications. Integration of small firms located located in the South of the World into GVCs is considered a win-win and is incentivized by many development and financial institutions. At the aggregate level efficiency increases thanks to the division of labor and specialization these systems of production create. Outsourcing firms benefit from lower production costs that translate into lower consumer prices. Producing firms in developing countries entry a market larger than the domestic one, gain access to more sophisticated production technologies and capital through foreign direct investments, benefits achievable only through the more dynamic export sector (Young, 1991; Krugman, 1987; Lucas, 1988;

Lucas Jr, 1993).

However, when countries specialize in value chain activities the Smile Curve describes not only value captured by firms, but also by countries themselves (Mudambi, 2008). High-value activities at the upstream and downstream end of GVCs are largely concentrated in advanced economies, while low-value activities in the middle are located in emerging economies and move in response to changes in economic conditions (Gereffi, 1999b; Shin et al., 2012). As such, most value is captured by high-income countries, further enhancing income disparities between countries.

Many development economist singled out backward and forward linkages[3]as a set of economic mechanisms that give rise to underdevelopment (Hirschman, 1958; Rostow, 2000; Rasmussen, 1956; Chenery, 1975) and affect the impact of trade-based development policies. Models of unbundling and offshoring based on Dixit-Stiglitz models focus on responses of production offshoring (Costinot et al., 2012; Grossman and Rossi-Hansberg, 2008) and the degree of control to exert over different stages of production (Antràs and Chor, 2013). Baldwin (2011) focuses on the effect of a policy chainge in a setting where domestic and imported components are partially substitutable and conclude that backward and forward linkages determine whether drops in tariffs increase the competitiveness of a country on a wider set of final goods.

This paper goes one step forward and investigate the source of backward and forward linkages differentials as grounded in horizontal and vertical competition (GVC governance). Formally, the model is close to Iapadre and Pace (2016) who use a Cournot oligopoly-oligopsony model to assess how the presence of intermediaries affects the impact of tariffs on consumer's prices. They find that much of the decrease

[3]"Backward linkages" are defined as foreign value added in gross exports of a country, while "forward linkages" as domestic value added that goes into the exports of other countries. The relationship between forward and backward linkages is important for countries to be gainfully included into GVCs. Most developed countries have forward linkages greater than backward linkages, but that is not the case for many emerging economies (Banga, 2013).

in tariffs is internalized by the intermediary firm as opposed to translate into lower retail prices. We build on this model by generalizing for a variable number of intermediary stages and number of competing firms per stage and shift the policy focus towards spillovers on producers and countries' economic development.

2.3 Intuition of the Model

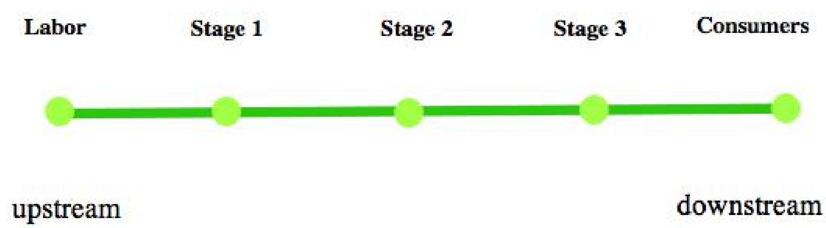


Figure 2.1: Value Chain with three intermediary stages.

This section provides an overview of the formal models at the base of our results. Readers uninterested in the mathematical derivation can focus on this section and skip Section 2.4.

A single product is manufactured by upstream firms (that for simplicity will be termed labor) and sold to consumers. Demand and supply do not meet directly, though. There are various intermediate stages (a fixed number). Each stage has a variable number of firms, oligopolists on that market, that compete á la Cournot[4]in buying the product from the previous stage and selling it to the subsequent one. The intermediary firms do not add any value to the final product: they pass it along until the final consumers. By abstracting from firm specific value added we can focus on the value they can capture given their position along the chain, competition, and information asymmetries.

In this linear value chain[5], production stages vary in the level of market information they have: the K stages are ordered according to the bargaining power firms have as driven by their relative level of information. In the PD model (Section 2.4.1), the level of information is the highest for upstream firms and decreases as they move along the value chain, giving upstream firms an advantage over the others. In particular, each firm knows the best response function of the firms downstream to it and consumers demand, but it is oblivious about production conditions and it only knows the final price set by firms in previous intermediary stages. The contrary is true for the BD model (Section 2.4.2): downstream stages have the most bargaining power because firms at each stage know the best response function of the previous firms but not the subsequent ones from which they receive a fixed price offer. The two models replicate the distinction between PD and BD value chains in GereffiGereffi (1994, 1999b). It assumes the critical asset that drives firms market power is their degree of information over market conditions.

[4]One of the key assumptions of the model is quantity competition à la Cournot. This choice yields closed-form solutions for profit shares continuous in the relevant parameters. It allows us to explore the effect of horizontal and vertical competition on firms' profits and total surplus. Competition in quantity does not fit every case. For instance, competition in prices takes place when firms bid over a wholesale price. However, the final results of the paper would still hold under price competition à la Bertrand. In fact, our results and policy implications focus on relative profits (profits over total surplus) and their ranking, which do not change with Bertrand competition. More on that will be discussed in Section 2.6.1

[5]The assumption the value chain is linear is also meant to simplify the analysis. Baldwin and

This modelling strategy outlines two levels of competition that drive firms' profits: horizontal and vertical competition. Horizontal competition is between firms at the same stage of the value chain and a hence with the same level of information about market conditions. Vertical competition is between firms at different stages of the value chain over the rents produced by the final sale. It is driven by the differential level of information they have. The interaction plays out as follows: in the PD (BD) model upstream (downstream) firms are able to forecast the best response function of firms downstream (upstream) to them and set the minimum price that those firms would accept given the competitive structure of that intermediary stage. They will concede a markup when the level of competition downstream (upstream) is lower. Rejecting the contract would leave the proposing firm out of viable alternatives. That markup is also going to depend on the level of competition at the upstream (downstream) stage that is proposing the pricing. The proposer knows that when it does not face competitors, the receiver will be more inclined to accept the offer due to its lack of alternatives over sourcing (retailing) options.

The two models yield closed-form solutions for profit shares of firms at the different production stages. As economic theory, GVC analysis and basic intuition would predict, high profit shares follow from low levels of competition and high levels of information. In the BD model when we fix the number of firms at each stage the shares of total profits are higher downstream than upstream. The contrary is true for the PD model. When every stage is perfectly competitive, results are identical in the two models (and identical to the case where there are no intermediary firms). Higher profits require a combination of both an horizontal and vertical level of market power.

Venables Baldwin and Venables (2013) define two types of value chain driven by the engineering characteristics of the manufactured goods: snake and spider value chains, i.e. linear value chains and the value chains where various inputs are assembled into an output. Nevertheless, we show in Section 2.6.3 that much of the policy conclusions do not vary if we expand our model into a spider value chain.

This framework clearly separates the effect of horizontal and vertical competition. Additionally, it replicates results that are well established in both the GVC and economic literature, supporting the policy results of Section 1.5.

2.3.1 The Intuition of the Producer Driven Model

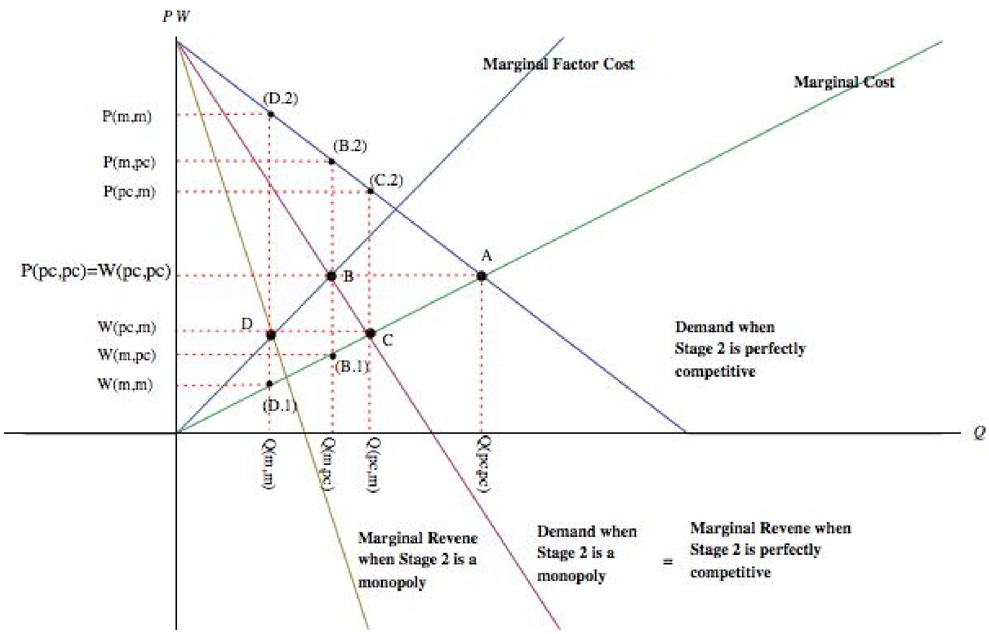


Figure 2.2*:* Intuition of the PD chain results: *Section 2.4.1 presents the functions in this figure. Values used in the graph are $K = 2$, $a = 100$, $b = 2$, $c = 0$, $f = 2$, $\gamma = 1$, $\delta_1 = 1$. The outcomes are described as $Q(\cdot,\cdot)$ for quantity, $P(\cdot,\cdot)$ for price amd $W(\cdot,\cdot)$ for wages, where the first the two parameters are the competitive structures of stage one and two, in this order. For instance: P(pc,m) indicates the price when stage 1 is perfectly competitive and stage 2 is a monopoly, While W(pc,m) represents the wage in the same competitive conditions. From Equation 2.4.3 we can see that the demand of goods to firm 1 depends on the level of competition at stage 2. To graphically simplify the analysis, take values of δ_1 equal to one, i.e. there are no transportation costs. By taking the extreme values N_2 can assume, we have that demand when $N_2 \to \infty$ is equal to $p_1(Q) \mid_{N_2 \to \infty} = a - bQ$, which is equal to the original demand. This corresponds to the blue line. Instead, when $N_2 = 1$, demand to firm 1 is equal to $p_1(Q) \mid_{N_2=1} = a - 2bQ$, which is twice as steep as the original demand and is represented in Figure 2.2 by the pink line. For any number $N_2 \in [1, \infty)$ there is a corresponding linear function in the cone between the two demand functions specified before. Similarly, the marginal revenue function for $N_2 \to \infty$ is twice as steep as the corresponding demand, represented by the pink line again. Finally, the MR function for $N_2 = 1$ is twice as steep at the corresponding demand, i.e. the yellow line.*

To simplify the intuition, think about a value chain with only two intermediary stages: a producer or labor that sells its products to intermediary stage one, who again passes on the product to firms at intermediary stage two that finally sells to the final consumers. Consumer demand and supply are linear. To give a sense of the workings of the model, this section will compare the extreme cases where at each intermediary stage there is either a monopolist/monosponist or an infinity of firms that operate under perfect competition. Four cases are outlined then, and to each of them corresponds an equilibrium point in Figure 2.2.

- At point A both intermediary stages are perfectly competitive. Firms at stage one do not impose any markup, because they operate in a perfectly competitive environment. Since stage two is also perfectly competitive, firms will also sell at cost. The final results is the same as it would have been without intermediation. In this case, wages are the highest and prices are the lowest. Profits for the firms in the two intermediary stages are equal to zero as expected in perfectly competitive industries.

- At point B intermediary stage one is a monopoly and intermediary stage two is perfectly competitive. As in the previous case, firms at stage two sell at cost. Since the value chain is PD, the monopolist at stage one know about both, the shape of demand (as mediated by firms at stage two) and the shape of supply. It will simultaneously act as a monopolist and a monopsonist on both sides of the market. Consumer and labor surplus shrinks to the advantage of stage one monopolist, while firms at stage two have zero profits due to the high degree of competition they face.

- At point C intermediary stage one is perfectly competitive, while intermediary stage two is a monopoly. The monopolist at stage two charges a markup on the unit wholesale price that is paid to stage one. Firms at stage one are perfectly competitive. Even though they observe the pricing strategies of the subsequent stage, they do not have market power and will not charge any markup. A comparison between equilibrium point B and C shows that restricting competition upstream in a PD model decreases total surplus more than decreasing competition downstream. Thanks to their bargaining power, upstream firms are better able to take advantage of the favorable competitive conditions.

- At point D both intermediary stages are monopolies. The monopolist at stage one charges a markup on the wholesale price paid to the previous intermediary stage. The monopolist at stage one, acts as a monopsonist with respect to labor as well as a monopolist with respect to firm two. This is why wages are the lowest, prices are the highest, final quantity sold is the lowest and total surplus is the lowest. Figure 2.3, represents the profits of the intermediary stages in scenario D. It shows that even though both firms face the same level of horizontal competition (they are both monopolists) firm one gets higher profits compared to firm two. In a PD value chain, in fact, firm one is stronger on the vertical competition dimension: it has an informational advantage. While the firm at stage one is both a monopsonists and a monopolist, the firm at stage two is only a monopolist because it does not have information about market supply.

2.3.2 The Intuition of the Buyer Driven Model

Keeping the same example with two intermediary stages, as in Section 2.3.1, in the BD model downstream firms are more informed than their upstream counterparts because they observe market conditions upstream and downstream to it. Upstream firms can only observe market conditions further upstream. Once again we will

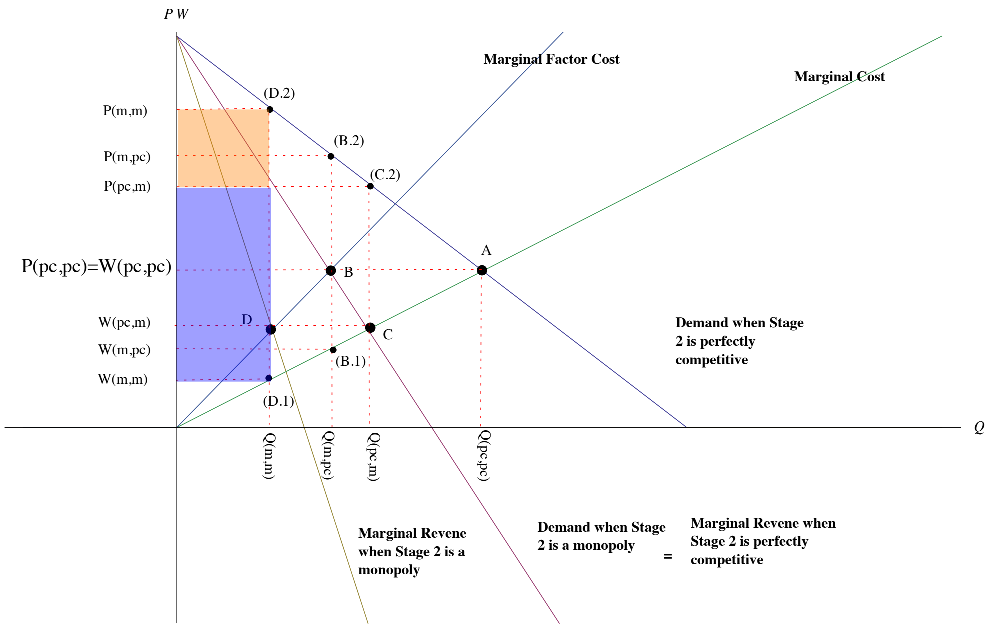


Figure 2.3*:* Producer Driven VC: Profit distribution between the two intermediary stages in Scenario D. *The area shaded in orange (upper shaded area) represents the final profits of firms at stage two, while the area shaded in blue (lower shaded area) represents the profits of firms at stage one.*

outline the intuition behind the Buyer Driven Model by comparing the extreme cases where each intermediary stage is a monopoly/monopsony or perfectly competitive, outlining the four cases that correspond to equilibrium points A to D in Figure 2.4.

- At point A both intermediary stages are perfectly competitive. Firms at stage one purchase the product for a wholesale price but do not impose any markup when reselling it to firms at stage two, because they operate in a perfectly competitive environment. Since stage two is also perfectly competitive, firms will sell at cost. The result is the same as in the PD case because power asymmetries do not matter when intermediary markets are perfectly competitive.

- At point B intermediary stage one is perfectly competitive, while intermediary stage two is a monopoly. The perfectly competitive firms at stage one do not charge any markup. Conversely, since the value chain is BD, the monopolist at stage two knows about the shape of demand (mediated by firms at stage

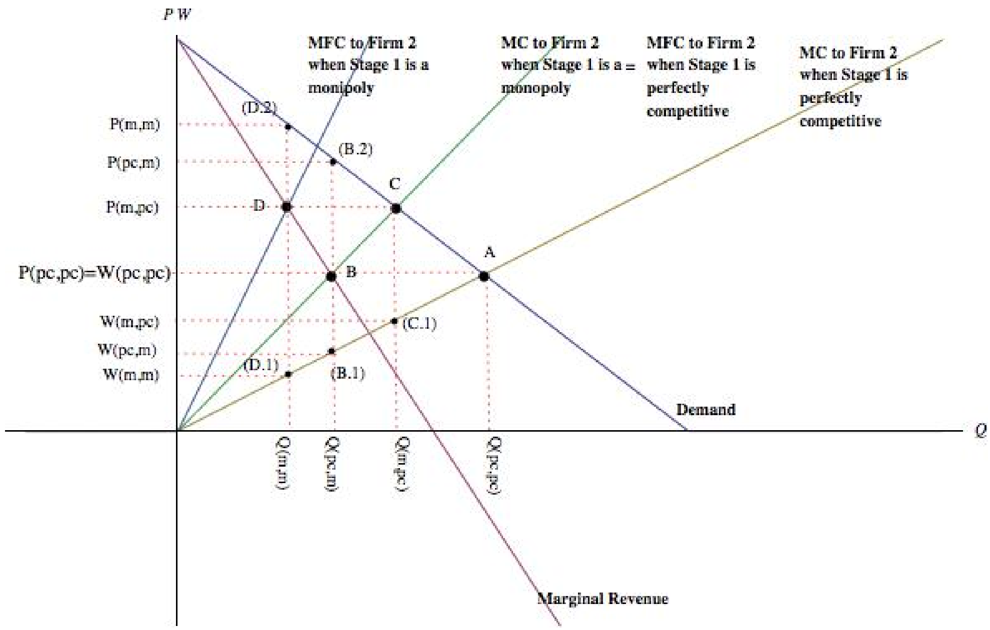


Figure 2.4*:* Intuition of the BD chain results: *Section 2.4.2 presents the functions in this figure. Value for the graph are:* $K = 2$, $a = 100$, $b = 2$, $c = 0$, $f = 2$, $\gamma = 1$, $\delta_1 = 1$. *The outcomes are described as* $Q(\cdot,\cdot)$ *for quantity,* $P(\cdot,\cdot)$ *for price amd* $W(\cdot,\cdot)$ *for wages, where the first the two parameters are the competitive structures of stage one and two, in this order. For instance: P(pc,m) indicates the price when stage 1 is perfectly competitive and stage 2 is a monopoly, While W(pc,m) represents the wage in the same competitive conditions. From equation (2.4.16) we can see that firm 2's supply function (marginal cost) depends on the level of competitiveness at stage 1. To graphically simplify the analysis, we take* δ_1 *equal to 1. Taking the two extreme cases, if firm 1 operates in perfect competition, then marginal cost to firm 1 is equal to* $c + fQ$ *(labor supply function, represented by the yellow line), while if firm 1 is a monopolist then the marginal cost to firm 2 is* $c + 2fQ$*, i.e. the green line. For any number* $N_1 \in [1, \infty)$ *there is a marginal cost function that lies in the cone between those two functions. Consequently, when stage 1 is perfectly competitive, the marginal factor cost function is twice as steep as the corresponding marginal cost function and therefore coincides with the green line again. Differently, the MFC function when stage 1 is monopolistic, is twice as steep as the corresponding MC, i.e. the blue line*

one) and the shape of supply. It can simultaneously act as a monopolist and a monopsonist. Consumer and labor surplus shrinks to the advantage of stage-one monopolist. Firms at stage two have zero profits due to the high degree of competition they face.

- At point C intermediary stage one is a monopoly and intermediary stage two is perfectly competitive. The firm at stage one the shape of supply and acts as a monopsonist. However, it does not observe downstream market conditions.

Thus, it cannot completely take advantage of its market power with respect to firms at stage two. The latter operate in a perfectly competitive scenario and are going to sell at cost. Despite their greater informational advantage, they are unable to profit from it given the high degree of horizontal competition. A comparison between equilibrium point B and C shows that restricting horizontal competition downstream in a BD model decreases total surplus more than decreasing competition upstream.

- At point D both intermediary stages are monopolies. The firm at stage acts as a monopsonist with respect to labor. This time, though, the firm at stage two is able to act as both a monopolist with respect to the final demand and a monopsonist with respect to the firm at stage one. This is why wages are the lowest, prices are the highest, final quantity sold is the lowest and total surplus is the lowest. Figure 2.5 shows the profits of the intermediary stages in scenario D. Even though both firms face the same level of horizontal competition (they are both monopolists), firm two gets higher profits compared to firm one. In a BD value chain, in fact, firm one is stronger on the vertical competition dimension: it has an informational advantage. It acts as a monopolist with respect to the demand, but also as a monopsonist with respect to firm one. Conversely, firm one can only profit as a monopsonist over labor, because it does not observe downstream market conditions.

2.3.3 Symmetric Information

What if all firms possess the same degree of information on market conditions? Then, there would be no advantage at the vertical level of competition. Both firms are simultaneously acting as monopolists and monopsonists.

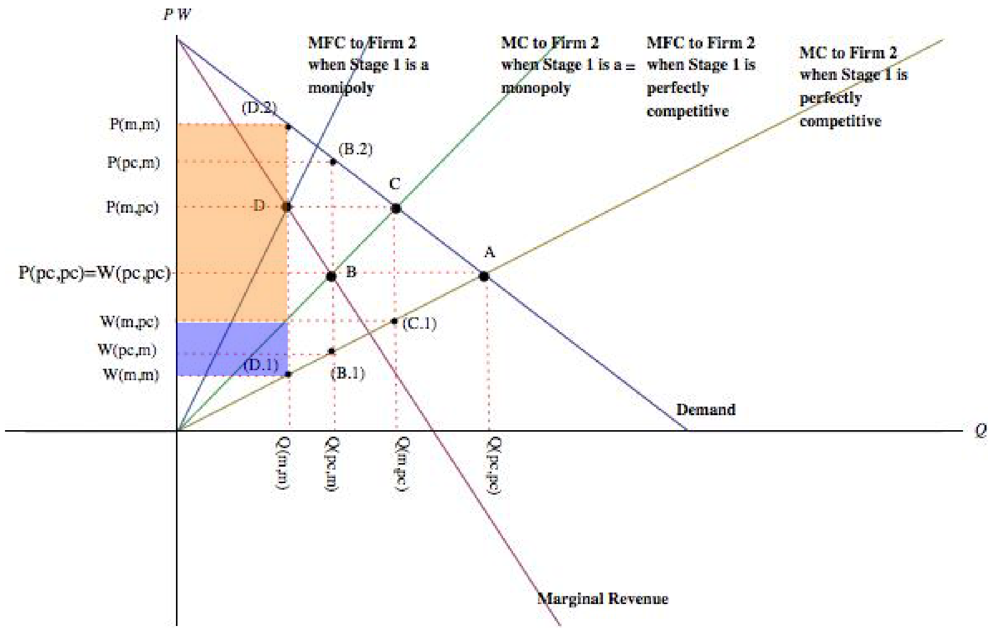


Figure 2.5*:* Buyer Driven VC: Profit distribution between the two intermediary stages in Scenario D *The area shaded in orange (upper shaded area) represents the final profits of firms at stage two, while the area shaded in blue (lower shaded area) represents the profits of firms at stage one.*

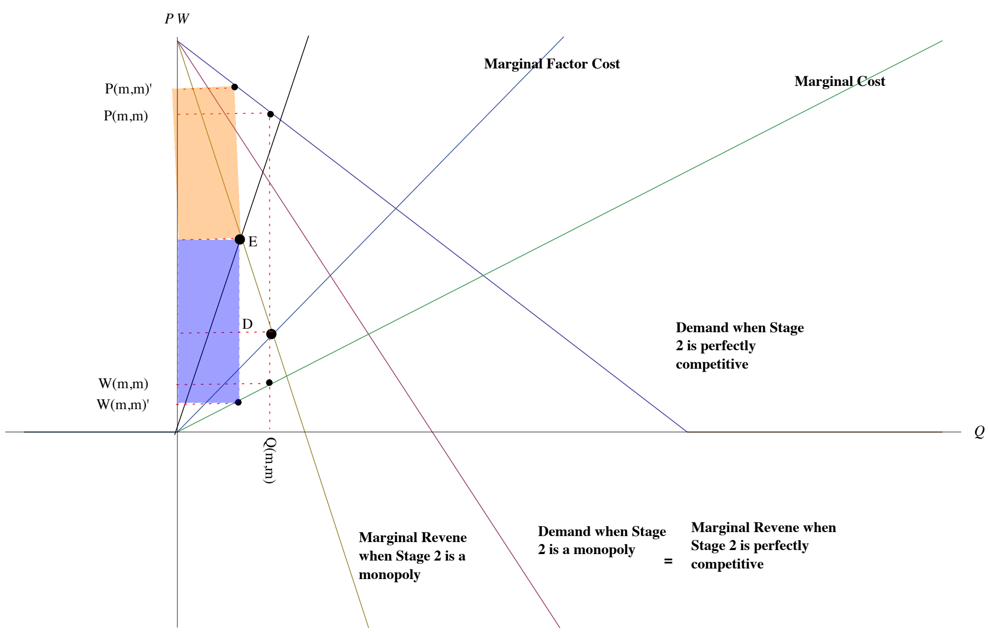


Figure 2.6*:* Profit distribution between the two intermediary stages when there is no informational advantage *The area shaded in orange represents the final profits of firms at stage two, while the area shaded in blue represents the profits of firms at stage one.*

Focusing on the scenario where there is only one firm per intermediary stage are monopolies, the firm at stage one is a monopsonist with respect to labor and a monopolist with respect to firm two. The firm at stage two is a monopolist with respect to the final demand and a monopsonist with respect to the firm at stage one. We then have four levels of markup. The final equilibrium is point E in Figure 2.6.

For comparison, Point D in Figure 2.6 is the equilibrium point with two monopolistic intermediaries in a PD value chain (point D in Section 2.3.1). Price increases, wages decrease together with final quantity sold, as we would expect from the introduction of another level of markup. The same would be true comparing to a BD value chain (point D in Section 2.3.2).

Nevertheless, the two intermediary firms divide their surplus equally, differently from the highly unequal division of profits in the PD value chain of Figure 2.3 and of the downstream firm in the BD value chain of Figure 2.5. This result is expected: if the levels of horizontal and vertical competition drive profits, and if both levels of competition are equal among the two firms, their profits should be equal.

2.4 Formal Model

2.4.1 Producer Driven Model

A linear value chain[6] with K (fixed and finite) stages connects demand and supply. Demand is linear and decreasing in quantity: $P(Q) = a - bQ$, where $a, b > 0$. Supply is upward sloping in Q: $W(Q) = c + fQ$ with $a > c \geq 0$ and $f > 0$.

Each intermediary stage $j \in [1, K]$ has a variable number of firms, oligopolists on

[6] Or a value chain of the snake type according to the taxonomy of Baldwin and Venables Baldwin and Venables (2013)

that market, that compete á la Cournot in buying the product from the previous stage and selling it to the subsequent one. The intermediary firms do not add any value to the final product: they pass it along until the final consumer. By abstracting from firm specific value added we can focus on the value they can capture given competition and information asymmetries (horizontal and vertical competition).

In the PD model, most downstream firms (at stage 3 in Figure 2.1), is presented with a flat supply function: the price dictated by firms at stage 2. Firms at stage 2, by backward induction, are able to predict the best response function of downstream firms. Firms at stage 2 can pick the offer price that maximizes their own profits, given the best response of firms at stage 3. To generalize, each firm in the chain optimizes given the best response function of the firms downstream to it, but knowing only the price set by the previous firm. It follows that each stage of the chain (keeping constant the number of competitors across stages) gets the greater slice of the residual surplus[7].

Solving by backward induction: at stage K each firm $i = 1, ..., N_K$ will pick quantity that maximizes profits of the form of Equation (2.4.1), where $\delta_{K-1} \geq 1$ is the iceberg transportation cost from stage $K-1$ to K.

$$\Pi_{i,K} = (a - b\sum_{j=1}^{N_K} q_{j,K})q_{i,K} - \delta_{K-1}p_{K-1}q_{i,K} \tag{2.4.1}$$

As all firms are identical, the resulting best response function for $q_{i,K}(p_{K-1})$ will set the maximum price that firms at stage K are willing to pay for the good. Hence, that will be the demand for firms at stage $K-1$. Those firms are going to receive a fixed price offer from firms at $K-2$ and so on. For K stages, any generic firm

[7]This is the case that is most commonly analyzed as the flow of information coincides with the physical timing of production. It represents a chain where the upstream firm produces directly for the final market and a set of retailers to sell the product to consumers.

at stage $j \in [2, K]$ has a best response function as in Equation (2.4.2), where δ_m represents the iceberg transportation cost between stage m to stage $m+1$ and N_m is the number of identical competitors at stage m.

$$q_j(p_{j-1}) = \frac{1}{1+N_j}\Big(\frac{a}{\prod_{m=j}^{K-1}\delta_m} - \delta_{j-1}p_{j-1}\Big)\Big(\frac{b}{\prod_{m=j}^{K-1}\delta_m}\prod_{m=j+1}^{K}\frac{1+N_m}{N_m}\Big)^{-1} \tag{2.4.2}$$

At the aggregate level, each intermediary stage j requires quantity $Q_j(p_{j-1}) = N_j q_j(p_{j-1})$ given the wholesale price offered by firms at the previous stage. This is the direct demand function of stage j. By inverting that function, we obtain the inverse demand function of stage j, as in Equation (2.4.3).

$$p_{j-1}(Q) = \frac{a}{\prod_{m=j}^{K-1}\delta_m} - \frac{b}{\prod_{m=j}^{K-1}\delta_m}\prod_{m=j+1}^{K}\frac{1+N_m}{N_m}Q \tag{2.4.3}$$

This new demand function is again linear and decreasing in Q. If $\delta_m = 1\,\forall m$, i.e. firms can freely transfer goods and every stage is perfectly competitive, this new demand function is identical to consumers' demand.

Each firm i (with $i = 1, ..., N_1$) at stage 1, the most upstream, observes the best response function of the firm directly upstream to it and maximizes a profit function as in Equation (2.4.4) with respect to quantities $q_{i,1}$.

$$\Pi_{i,1} = \Big(\frac{a}{\prod_{m=1}^{K-1}\delta_m} - \frac{b}{\prod_{m=1}^{K-1}\delta_m}\prod_{m=2}^{K}\frac{1+N_m}{N_m}\sum_{j=1}^{N_1}q_{j,1}\Big)q_{i,1} - \Big(c + f\sum_{j=1}^{N_1}qj,1\Big)q_{i,1} \tag{2.4.4}$$

Each firm i at stage 1 picks the optimal quantity $q_{i,1}^*$ of the form of Equation (2.4.5). By substituting total stage 1 optimal supply $Q_1^* = N_1 q_{i,1}^*$ into Equation (2.4.3), we get the optimal pricing of firms at stage 1, as in Equation (2.4.6).

$$q^*_{i,1} = \frac{1}{1+N_1}\Big(\frac{a}{\prod_{m=1}^{K-1}\delta_m} - c\Big)\Big(\frac{b}{\prod_{m=1}^{K-1}\delta_m}\prod_{i=2}^{K}\frac{1+N_i}{N_i} + f\Big)^{-1} \tag{2.4.5}$$

$$p^*_1 = \frac{a}{\prod_{m=1}^{K-1}\delta_m} - \frac{b}{\prod_{m=1}^{K-1}\delta_m}\frac{N_1}{1+N_1}\prod_{m=2}^{K}\frac{1+N_m}{N_m}AB^{-1} \tag{2.4.6}$$

With $A = \frac{a}{\prod_{m=1}^{K-1}\delta_m} - c$ and $B = \frac{b}{\prod_{m=1}^{K-1}\delta_m}\prod_{m=2}^{K}\frac{1+N_m}{N_m} + f$.

By substituting p^*_1 into the best response functions of the previous stages and iterating in this fashion we get the equilibrium results for quantities, equation (2.4.7), and for prices, equation (2.4.8), for all stage $j \in [2, K]$.

$$Q^*_j = \frac{N_1}{1+N_1}\Big(\frac{a}{\prod_{m=1}^{K-1}\delta_m} - c\Big)\Big(\frac{b}{\prod_{m=1}^{K-1}\delta_m}\prod_{m=2}^{K}\frac{1+N_m}{N_m} + f\Big)^{-1} \tag{2.4.7}$$

$$p^*_j = \frac{a}{\prod_{m=j}^{K-1}\delta_m} - \frac{b}{\prod_{m=j}^{K-1}\delta_i}\frac{N_1}{1+N_1}\prod_{m=j+1}^{K}\frac{1+N_m}{N_m}AB^{-1} \tag{2.4.8}$$

Resulting profits of all firms at each stage as well as consumer, labor and total surplus are as in equation (2.4.9), equation (2.4.10), equation (2.4.11), (2.4.12) and (2.4.13) respectively.

$$\Pi^*_1 = \frac{1}{(1+N_1)^2}A^2B^{-1} \tag{2.4.9}$$

$$\Pi^*_j = \frac{1}{N_j^2}\Big(\frac{N_1}{1+N_1}\Big)^2\frac{b}{\prod_{m=j}^{K-1}\delta_m}\prod_{m=j+1}^{K}\frac{1+N_m}{N_m}A^2B^{-2} \tag{2.4.10}$$

$$CS = \frac{b}{2}\Big(\frac{N_1}{1+N_1}\Big)^2A^2B^{-2} \tag{2.4.11}$$

$$LS = \frac{f}{2}\Big(\frac{N_1}{1+N_1}\Big)^2 A^2 B^{-2} \tag{2.4.12}$$

$$TS = \Big(\frac{N_1}{1+N_1}\Big)^2 A^2 B^{-2}\Big(\frac{b+f}{2} + \frac{B}{N_1} + \sum_{j=2}^{K} \frac{b}{N_j}\frac{1}{\prod_{i=j}^{K-1}\delta_i}\prod_{i=j+1}^{K}\frac{N_i+1}{N_1}\Big) \tag{2.4.13}$$

2.4.2 Buyer Driven Model

This section reverses the governance structure of the Section 2.4.1 assuming that information about market condition is increasing along the value chain. The firm closer to the consumer (firms at stage 3 in Figure 2.1) is informed about the shape of the demand function. At the same time, it is able to observe the characteristics of the previous production stages and to infer the best response functions of all the firms upstream to it. To generalize, each firm in the chain optimizes given the best response function of the previous firms, but oblivious about the best response function of the subsequent firms from which they get a fixed price offer.

Demand and supply are identical to Section 2.4.1. Solving by backward induction: firms at stage 1 face a flat demand given by the fixed price that firms at stage 2 set. Every firm $i = 1, ..., N_1$ that competes on market 1 picks the quantity that maximizes a profit function as in equation (2.4.14) with respect to the quantities produced, where $p_2 \geq 0$ is the price set by firms at stage 2, $\delta_1 \geq 1$ is the iceberg transportation cost from stage 1 to stage 2, $q_{i,1}$ is the quantity supplied by each individual firm i at stage 1.

$$\Pi_{i,1} = \delta_1 p_2 q_{i,1} - (c + f\sum_{j=1}^{N_1} q_{j,1})q_{i,1} \tag{2.4.14}$$

As all firms are identical, they will pick the same quantity. The best response function of each firm i at stage 1 to the price picked by firms at stage 2 in equation (2.4.15). Aggregate supply by stage 1 as a function of p_2 is $Q_1(p_2) = N_1 q_{i,1}(p_2)$.

$$q_{i,1}(p_2) = \frac{1}{1+N_1}\frac{\delta_1 p_2 - c}{f} \tag{2.4.15}$$

Inverting the $Q_1(p_2)$ function and we get the marginal cost to firms at stage 2 for the quantity, obtaining equation (2.4.16).

$$p_2(Q) = \frac{c}{\delta_1} + \frac{f}{\delta_1}\frac{1+N_1}{N_1}Q \tag{2.4.16}$$

This marginal cost function is still a linear function increasing in Q. If there are no transportation costs ($\delta_1 = 1$) and firms at stage 1 operate in perfect competition ($N_1 \to \infty$), it is identical to the supply function $W(Q)$. When there is only one firm at stage 1 the function is twice as steep. Any function in the cone between the two are possible supply functions for a given number of competitors at stage 1[8].

Given this marginal cost function, firms at stage 2 pick the optimal quantity and price p_2 as a function of the flat price offered by firm 3 (p_3), which in turn is a function of p_4, the price picked by firm 4, and so on. Firms at the most downstream stage (K) face demand and they pick a final price that cascades into the best responses of firms in all other stages and solves the system.

For K stages, any generic firm i (with $i = 1, .., N_j$) at stage $j \in [1, K-1]$ has best response function to the price set by upstream firms for quantity as in equation (2.4.17).

[8] In Figure 2.4 any function in the cone between the two supply functions represents supply for any number of competitors $N_1 \in (1, \infty)$. Similarly, any function in the cone between the two marginal factor costs (MFC) represents the MFC for any number of competitors $N_1 \in (1, \infty)$.

$$q_{i,j}(p_{j+1}) = \frac{1}{1+N_j}\Big(\delta_j p_{j+1} - \frac{c}{\prod_{m=1}^{j-1}\delta_m}\Big)\Big(\frac{f}{\prod_{m=1}^{j-1}\delta_m}\prod_{m=1}^{j-1}\frac{1+N_m}{N_m}\Big)^{-1} \tag{2.4.17}$$

Total quantity supplied by stage j to stage $j+1$ is equal to $Q_j(p_{j+1}) = N_j q_{i,j}(p_{j+1})$. By inverting the function $Q_j(p_{j+1})$ we get the marginal cost for firm $j+1$ as in equation (2.4.18).

$$p_{j+1}(Q) = \frac{c}{\prod_{m=1}^{j}\delta_m} + \frac{f}{\prod_{m=1}^{j}\delta_m}\prod_{m=1}^{j}\frac{1+N_m}{N_m}Q \tag{2.4.18}$$

At stage K, firms can observe the best response function q_{K-1} of their suppliers as well as the demand of the final consumers. The problem of any firm $i = 1, ..., N_K$ at stage K is to maximize a profit as in equation (2.4.19).

$$\Pi_{i,K} = (a - b\sum_{j=1}^{N_K} q_{j,K})q_{i,K} - \Big(\frac{c}{\prod_{m=1}^{K-1}\delta_m} + \frac{f}{\prod_{m=1}^{K-1}\delta_m}\prod_{m=1}^{K-1}\frac{1+N_m}{N_m}\sum_{j=1}^{N_K} q_{j,K}\Big)q_{i,K} \tag{2.4.19}$$

The resulting optimal quantity bought and resold by each identical firm at stage K is q_K^* that yields aggregate supply to the consumers $Q_K^* = N_K q_K^*$ of equation (2.4.20).

$$Q_K^* = \frac{N_K}{1+N_K}\Big(a - \frac{c}{\prod_{m=1}^{K-1}\delta_m}\Big)\Big(b + \frac{f}{\prod_{m=1}^{K-1}\delta_m}\prod_{i=1}^{K-1}\frac{1+N_m}{N_m}\Big)^{-1} \tag{2.4.20}$$

By recursively substituting Q_K^* into the marginal cost functions $p_{j+1}(Q)$ and then into the best response functions of the previous stages and iterating in this fashion we get the equilibrium results for prices in equation (2.4.21) for all stage $j \in [1, K]$.

$$p_j^* = \frac{c}{\prod_{m=1}^{j-1}\delta_m} + \frac{f}{\prod_{m=1}^{j-1}\delta_m}\prod_{m=1}^{j-1}\frac{1+N_i}{N_i}\frac{N_K}{1+N_K}CF^{-1} \tag{2.4.21}$$

With $C = a - \frac{c}{\prod_{m=1}^{K-1}\delta_m}$ and $F = b + \frac{f}{\prod_{m=1}^{K-1}\delta_m}\prod_{i=1}^{K-1}\frac{1+N_m}{N_m}$.

Resulting profits of all firms at each stage are in equation (2.4.22) and equation (2.4.23), while consumer, labor and total surplus are in equation (2.4.24), (2.4.25) and (2.4.26), respectively.

$$\Pi_K^* = \frac{1}{(1+N_K)^2}C^2F^{-1} \tag{2.4.22}$$

$$\Pi_j^* = \frac{1}{(N_j)^2}\frac{f}{\prod_{m=1}^{j-1}\delta_m}\prod_{m=1}^{j-1}\frac{1+N_m}{N_m}\Big(\frac{N_K}{1+N_K}\Big)^2C^2F^{-2} \tag{2.4.23}$$

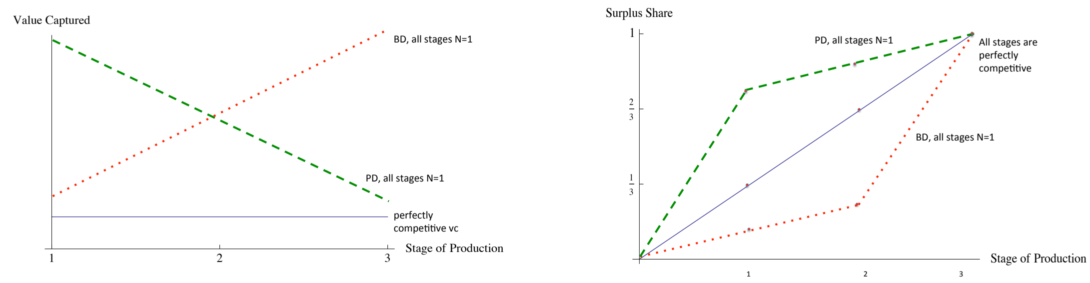
$$CS = \frac{b}{2}\Big(\frac{N_K}{1+N_K}\Big)^2C^2F^{-2} \tag{2.4.24}$$

$$LS = \frac{f}{2}\Big(\frac{N_K}{1+N_K}\Big)^2C^2F^{-2} \tag{2.4.25}$$

$$TS \quad = \Big(\frac{N_K}{1+N_K}\Big)^2C^2F^{-2}\Big(\frac{b+f}{2} + \frac{F}{2} + \sum_{j+1}^{K-1}\frac{f}{N_j}\frac{1}{\prod_{i=1}^{j-1}}\prod_{i=1}^{j-1}\frac{N_i+1}{N_i}\Big) \tag{2.4.26}$$

2.5 Results: profit shares rankings

This paper focuses on the distribution of profits between the firms comprising the value chain rather than the absolute values of those profits. Two sets of results on profit distribution emerge from the models described in the previous sections. The



(a) Value Captured *(b)* Surplus Shares

Figure 2.7*:* Surplus in a Value Chain with Three Equally Competitive Intermediary Stages *The x axis represents the three stages of the value chain, as for the example. The y axis represents total value captured in Subfigure 2.7a and share of surplus (profits of each individual firm at a given intermediary stage over total surplus) in Subfigure 2.7b. The solid blue line represents the scenario where all three intermediary stages are perfectly competitive, in both a Producer Driven and a Buyer Driven value chain. Surplus shares when all intermediary stages are monopolies (*$N_1 = N_2 = N_3 = 1$*) are represented by the green dashed line for a Producer Driven value chain and the red dotted line for a Buyer Driven value chain.*

first one is that in a PD (BD) model the share of surplus of each firm is decreasing (increasing) in their position in the chain, keeping competition constant across stages and as long as transportation costs are not too high[9]. The second result shows that market power at the vertical and horizontal lever are partially substitutable.

Proposition 2.5.1. *As long as transportation costs are not too high, i.e.* $\frac{1}{\delta_m} \leq 1 + \frac{1}{N_m}\ \forall m$*, in a Producer Driven value chain, firms profit follow the following patterns for a given level of competition:* $N_{j+h} = N_j \Rightarrow \Pi^*_{j+h} \leq \Pi^*_j \forall j, h \in [0, K-j]$

In a Buyer Driven value chain, instead, firms' profits follow the following patterns for a given level of competition: $N_{j+h} = N_j \Rightarrow \Pi^*_{j+h} \geq \Pi^*_j\ \forall j, h \in [0, K-j]$

Proposition 2.5.1 formalizes the first result, with proof in Appendix A.1. If all intermediary stages are perfectly competitive then all firms get the same share of total

[9] We are going to keep the assumption that transportation costs are not too high through the rest of the paper, in fact, if transportation costs were too high the value chain would not be the preferred production method and firms would internalize production

surplus: all of them get zero profits. This holds in both the PD and BD scenario because horizontal competition nullifies the effect of information asymmetries. When all stages are monopolies, instead, information asymmetries matter. In a PD value chain the firm at stage one gets most of the profits, while the other two share what is left. In a BD value chain the most downstream firm, stage 3 in Figure (2.7b), gets the highest share of profits. If we let numbers of competitors increase equally in all stages of the value chain, then the red dotted and green dashed line in Figure 2.7b would decrease their convexity/concavity until they converge to the straight blue line: the perfectly competitive case. Hence, when we keep competition constant across stages, downstream firms are always better off in a BD value chain, while upstream firms are better off in a PD value chain. This result is consistent with the GVC literature.

When competition varies at the different stages of the value chain, for downstream firms to have greater profits it must be the case that the difference in the number of firms in the two stages is small enough. It needs to be small, but not necessarily equal to zero. The advantageous position of downstream (upstream) firms compared to upstream (downstream) firms in a BD (PD) chain allows the downstream (upstream) stage to be more profitable despite it being relatively more competitive, up to a certain point. Proposition 2.5.2 formalizes this intuition. Proof is provided in Appendix A.2.

Proposition 2.5.2. *In a Producer Driven value chain,* $\Pi^*_{j+1} \leq \Pi^*_j \, \forall j$ *if and only if* $\frac{N_j}{N_{j+1}} \leq \bar{m}$ *with* $\bar{m}$ *small enough, but not necessarily equal to one. In a Buyer Driven value chain,* $\Pi^*_{j+1} \geq \Pi^*_j \, \forall j$ *if and only if* $\frac{N_{j+1}}{N_j} \leq \bar{n}$ *with* $\bar{n}$ *small enough, but not necessarily equal to one.*

Proposition 2.5.2 combines the effects of the horizontal and vertical competition and it analyzes their interaction. Proposition 2.5.1 only considers the effect of vertical competition. The straight lines in Figure (2.7a) can assume a variety of shapes depending on the degree of horizontal competition at each stage. Lead firms (the most upstream in a PD value chain and the most downstream in a BD value chain) need not be the ones facing the least horizontal competition to capture the most value and hence to get the highest share of surplus.

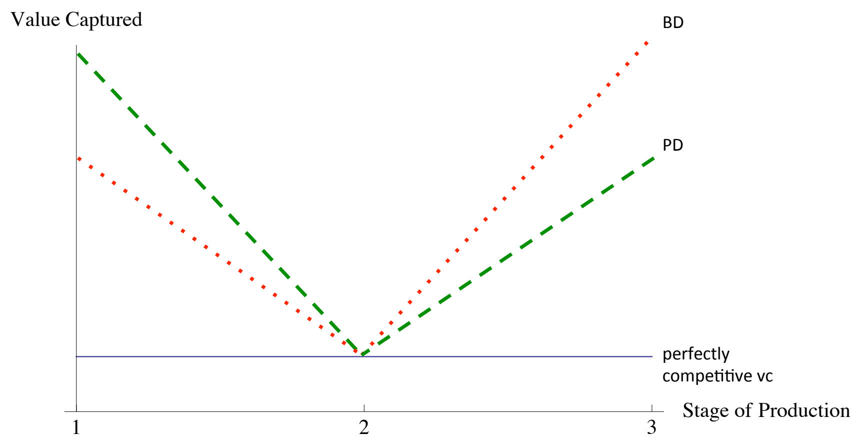


Figure 2.8*:* Surplus in a Value Chain with Three Intermediary Stages that Vary in Competitive Levels: *The x axis represents the three stages of the value chain, as for the example. The y axis represents value captured. The solid blue line represents the scenario where all three intermediary stages are perfectly competitive, in both a Producer Driven and a Buyer Driven value chain. Value captured when intermediary stages 1 and 3 are monopolies ($N_1 = N_3 = 1$) while intermediary stage 2 is perfectly competitive are represented by the green dashed line for a Producer Driven value chain and the red dotted line for a Buyer Driven value chain.*

The model replicates the Smile Curve (Shih, 1996). Assuming there are entry barriers that decrease horizontal competition upstream (stage 1) and downstream (stage 3), but not in the middle stages (stage 2), as in (Shih, 1996), the model produces Figure 2.8. The result looks very much alike a Smile Curve, with upstream and downstream stages capturing most of the value at the expenses of the middle of the value chain. Figure 2.8 shows that in a PD value chain, the leader at the upstream end of the value chain captures more value than the downstream firm, even though they face the same level of horizontal competition. The contrary is true for a BD value chain. Their advantage at the vertical level of competition drives the wedge between the value they capture.

Proposition 2.5.1 and Proposition 2.5.2 show that this model can replicate the major results of the GVC literature as well as the Smile Curve setting itself as a good organizer of those contributions.

2.5.1 Trade Costs

Trade costs decrease thanks to broader trade facilitation measures, such as tariff reductions, improvement of transportation and communication infrastructure both within and across countries, reforms to customs and border measures, standardization across countries and so on. They are common development policies. Many developing countries have already unilaterally lowered tariffs on imported parts with mixed results on their industrialization patterns (Baldwin and Venables, 2015; Rodrik, 2016).

These types of interventions correspond to a decrease in δ_i, with $i \in [1, K-1]$, in the models of section 2.4.1 and 2.4.2 . Consistently with the economic literature on the topic, a decrease in δ_i, for any stage of production i, leads to an increase in total surplus and an increase in surplus of all firms, consumers and labor. Every firm in the value chain benefits in absolute terms. However, the majority of this extra surplus goes to the leader of the chain. When designing policies to benefit upstream producers, then, governance within value chains should be consider to avoid the benefits of costly interventions to escape the target country.

Proposition 2.5.3. *Define π_i, cs and ls respectively the profits of firms at stage i, with $i \in [1, K]$, relative to total surplus, consumer surplus relative to total surplus* *and labor surplus relative to total surplus, i.e.* $\pi_i = \frac{\Pi_i}{TS}$; $cs = \frac{CS}{TS}$; $ls = \frac{LS}{TS}$. *Then, in a Producer Driven value chain, firms' profit shares display the following patterns for any level of competition:*

1. $\frac{\partial \pi_i}{\partial \delta_j} \leq 0 \iff j \geq i$

2. $\frac{\partial \pi_i}{\partial \delta_j} \geq 0 \iff j < i$

The contrary is true for a Buyer Driven value chain, i.e.

1. $\frac{\partial \pi_i}{\partial \delta_j} \geq 0 \iff j \geq i$

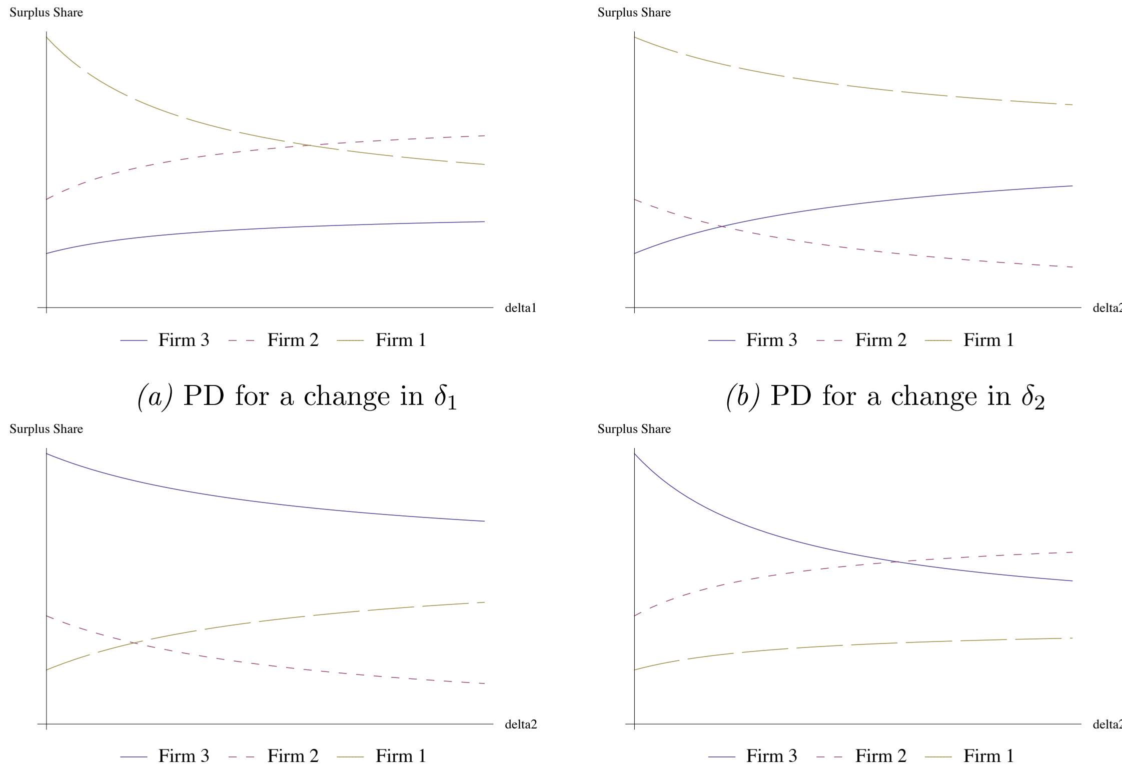
2. $\frac{\partial \pi_i}{\partial \delta_j} \leq 0 \iff j < i$

While, in both models we have that:

1. $\frac{\partial cs}{\partial \delta_j} \geq 0 \forall j$

2. $\frac{\partial ls}{\partial \delta_j} \geq 0 \forall j$

Proposition 2.5.3 (proof in Appendix A.3) states that, in a PD model, a firm will benefit relatively more than the others if the decrease in transportation cost takes place downstream to it. Its profits are going to increase less than the increase in total surplus when transportation costs accrue upstream to it. When transportation costs decrease, profits of all firms increase. However, upstream (downstream) firms benefit relatively more in a PD (BD) value chain. Figures (2.9a) and (2.9b) show that: when trade costs between stage one and two decrease - a movement to the left on the x axis in Figure (2.9a) - firms at stage one, experience an increase in relative surplus, at the expense of firms in stage two and three. Similarly, if trade costs between stage two and three decrease, firms at stage one and two experience an increase in relative surplus, at the expense of firms at stage three.



(a) PD for a change in δ_1

(b) PD for a change in δ_2

(c) BD for a change in δ_1

(d) BD for a change in δ_2

Figure 2.9*:* Surplus Shares in a Value Chain with Three Intermediary Stages as a Function of Trade Costs: *The x axis represents N_2, the number of firms at stage 2. The y axis represents the individual firm share of surplus given its stage of production. Subfigures 2.9a and 2.9b are the results for a change in trade costs in a PD model. Subfigures 2.9c and 2.9d in a BD model.*

The contrary is true in a BD value chain. When trade costs between stage one and two decrease - Figure (2.9c) - downstream firms benefit relatively more than firms at stage one. When trade costs between stage two and three decrease - Figure (2.9d) - downstream firms benefit relatively more than firms at stage one and two. This effect is independent of the levels of horizontal competition at each stage. Consumers and labor, however, always see a decrease in their relative profits after a decrease in transportation costs at any stage and in both versions of the model.

It follows that, for instance, if the objective is to benefit the country where the second intermediary stage takes place, and the industry is BD, it is a better choice to decrease import duties on inputs, rather than export duties on outputs because more of the increase in aggregate surplus (which is equal in the two cases) would stick to firms at stage two.

2.5.2 Horizontal Competition

For a long time development policies have focused on fostering more competitive market environments (Williamson, 1990; Rodrik, 2006). Dismantling state monopolies, for instance, has been a widely adopted measure (Rodrik, 1998, 2006). Increasing competition aims at attracting foreign investments and foster inclusion into GVCs. (Dis)Incentivizing workers' unions or product differentiation also affect horizontal competition. In the model presented, an increase in competition at stage j makes profits and relative profits decrease for stage j's firms. Each firm, at any stage of production, prefers to be a monopolist and it prefers every other stage to be perfectly competitive. If firms could increase the competitiveness of one stage of the value chain, what stage would they pick? This section focuses on how higher levels of horizontal competition one one stage spill over to other stages of the value chain.

Proposition 2.5.4 (proof in Appendix A.4) answers this question. When the level of competition increases, total surplus increases. The model shows that most of this extra surplus benefits the lead firm: the firms with most information about market conditions.

When in a PD value chain horizontal competition increases at one intermediary stage - stage two in Figures (2.10a) and (2.10b) - firms downstream to it are relatively better off than firms upstream to it (as shown by the slope of the solid blue and dashed yellow line) at the expense of firms at the stage where the increase in competition took place. This effect is stronger when the leader of the chain is not a monopolist -

Figure (2.10b). In a BD value chain, instead, upstream firms are going to be better off than downstream firms from an increase in competition in intermediary stage two -Figures (2.10c) and (2.10d).

Proposition 2.5.4. *In a Producer Driven value chain, firms' profit shares display the following patterns in response to an increase in competition:*

1. $\frac{\partial \pi_i}{\partial N_j} \leq 0 \iff j > i$

2. $\frac{\partial \pi_i}{\partial \delta_j} \geq 0 \iff j < i$

The contrary is true for a Buyer Driven value chain, i.e.

1. $\frac{\partial \pi_i}{\partial \delta_j} \geq 0 \iff j > i$

2. $\frac{\partial \pi_i}{\partial \delta_j} \leq 0 \iff j < i$

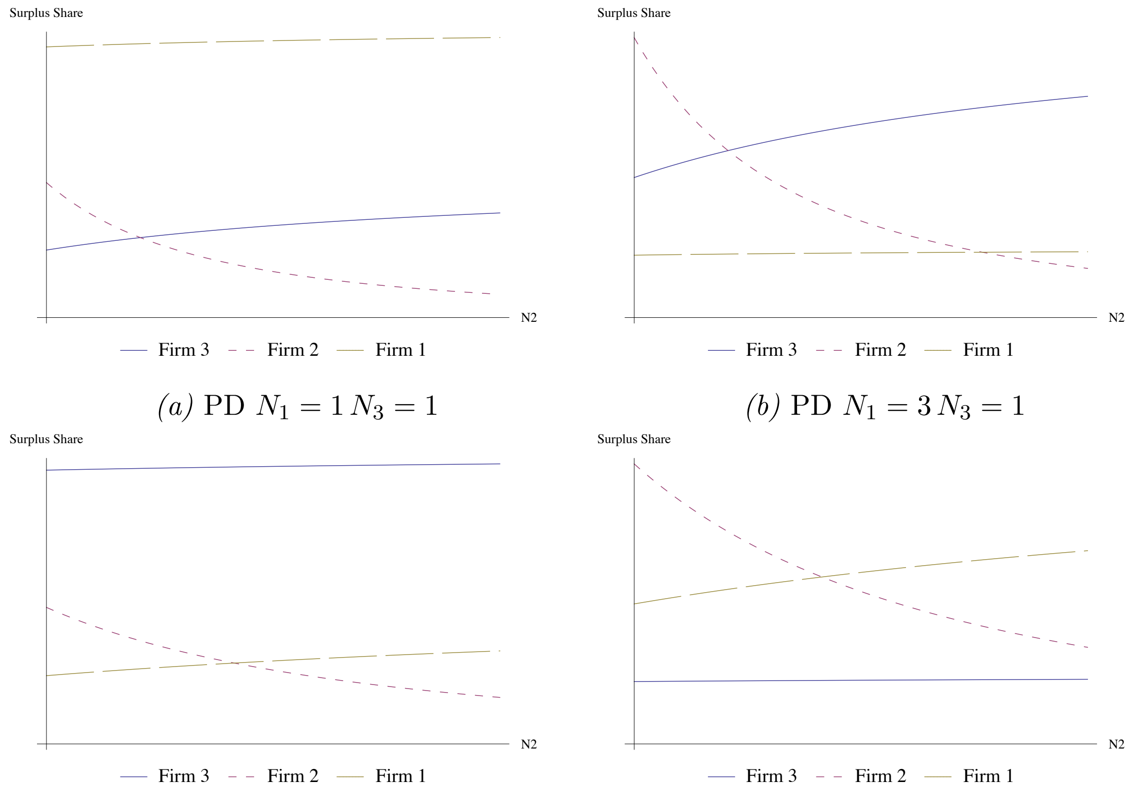
While, in both models we have that:

1. $\frac{\partial cs}{\partial \delta_j} \geq 0 \forall j$

2. $\frac{\partial ls}{\partial \delta_j} \geq 0 \forall j$

2.5.3 Demand

Changes in demand characteristics also change relative profits. All production stages benefit from an increase in demand and when demand decreases profits at each intermediary stage are equally damaged. Changes in the elasticity of demand affect firms' profits differently depending on horizontal and vertical competition. In both PD and BD value chain (Figure 1.11) an inelastic demand means stronger buyers, increasing vertical power and hence profits of downstream firms. This intuition is formalized in Proposition 2.5.5 with proof in Appendix A.5.



(a) PD $N_1 = 1\, N_3 = 1$ *(b)* PD $N_1 = 3\, N_3 = 1$

(c) BD $N_1 = 1\, N_3 = 1$ *(d)* BD $N_1 = 1\, N_3 = 3$

Figure 2.10*:* Surplus Shares in a GVC with Three Intermediary Stages as a Function of Competition at Stage 2: *The x axis represents N_2, the number of firms at stage of production 2. The y axis represents the individual firm share of surplus given its stage of production. Subfigures (2.10a) and (2.10b) are results for a PD model and subfigures (2.10c) and (2.10d) for a BD Model.*

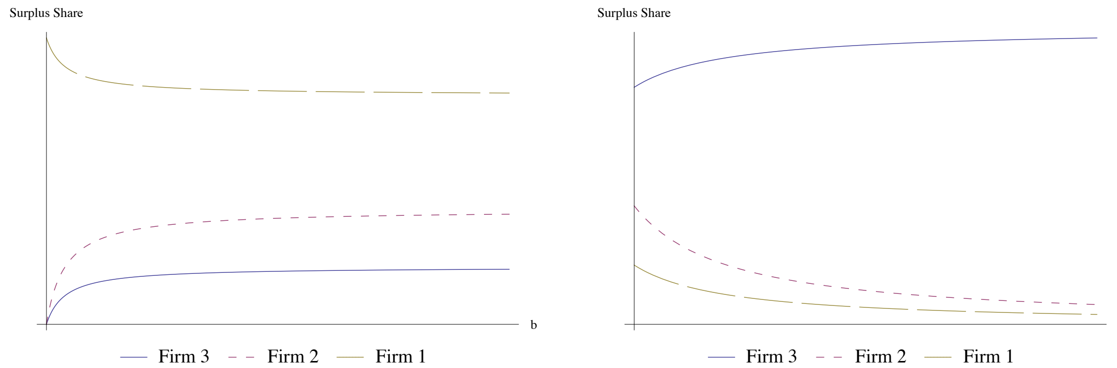
Campaigns aiming at boosting or mitigating demand for products from certain countries or firms should consider the widespread effects on the entire value chain and what segments of production are most affected by the intervention.

Proposition 2.5.5. *Firms' profit shares display the following patterns in response to changes in demand in both a Producer Driven and a Buyer Driven Value chain:*

1. $\frac{\partial \pi_i}{\partial a} = \frac{\partial cs}{\partial a} = \frac{\partial ls}{\partial a} = 0$

2. $\frac{\partial cs}{\partial b} \geq 0$

3. $\frac{\partial ls}{\partial b} \leq 0$



(a) PD *(b)* BD

Figure 2.11*:* Surplus Shares in a GVC with Three Intermediary Stages as a Function of Demand Conditions: *The x axis represents b, the slope of demand. The y axis represents the individual firm share of surplus given its stage of production.*

The effect of changes in elasticity of demand on firms' surplus shares depend on the type of value chain:

1. $\frac{\partial \pi_i}{\partial b} \geq 0 \, \frac{\partial \pi_1}{\partial b} \leq 0 \iff$ *the value chain is Producer Driven*

2. $\frac{\partial \pi_i}{\partial b} \leq 0 \, \frac{\partial \pi_K}{\partial b} \geq 0 \iff$ *the value chain is Buyer Driven*

2.5.4 Supply

Proposition 2.5.6 (proof in Appendix A.6) shows that an upward shift in supply decreases the surplus of all intermediary stages equally and hence total surplus of the same proportion. The relative effect of changes in supply characteristics on intermediary firms' profits depends on horizontal and vertical competition. However, in both PD (Figure 2.12a) and BD (Figure 2.12b) value chains an inelastic supply function means a stronger producer, further increasing the vertical power of upstream firms.

Proposition 2.5.6. *Firms' profit shares follow the following patterns in response to changes in supply in both a Producer Driven and a Buyer Driven Value chain:*

1. $\frac{\partial \pi_i}{\partial c} = \frac{\partial cs}{\partial c} = \frac{\partial ls}{\partial c} = 0$

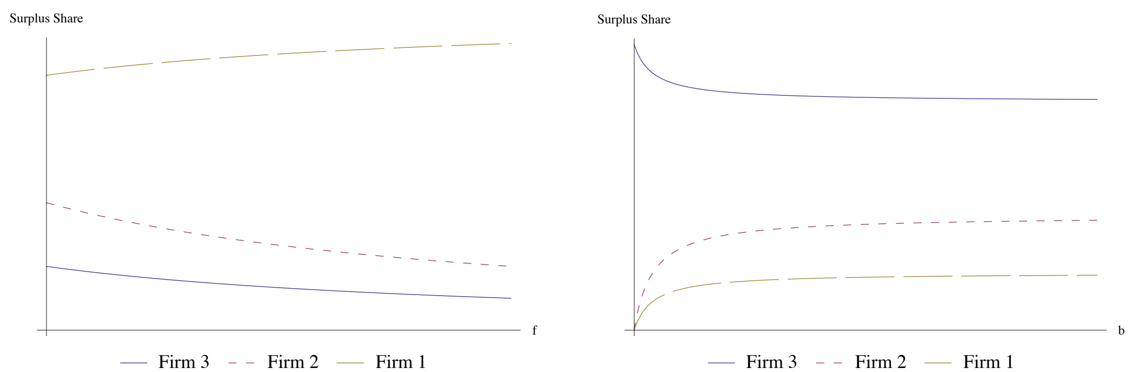
2. $\frac{\partial cs}{\partial f} \leq 0$

3. $\frac{\partial ls}{\partial f} \geq 0$

The effect of changes in elasticity of supply on firms' surplus shares depend on the type of value chain:

1. $\frac{\partial \pi_i}{\partial f} \leq 0 \, \frac{\partial \pi_1}{\partial f} \geq 0 \iff$ *the value chain is Producer Driven*

2. $\frac{\partial \pi_i}{\partial f} \geq 0 \, \frac{\partial \pi_K}{\partial f} \leq 0 \iff$ *the value chain is Buyer Driven*



(a) PD *(b)* BD

Figure 2.12*:* Surplus Shares in a GVC with Three Intermediary Stages as a Function of Supply Conditions: *The x axis represents f, the slope of supply. The y axis represents the individual firm share of surplus given its stage of production.*

2.6 Discussion

This paper derives policy conclusions based on a specific set of assumptions. This section discusses three of these assumptions: firms competing in quantities and not prices (Section 2.6.1), the structure of the value chain being exogenously fixed (Section 2.6.2); and the trade off between a linear value chain and a more complex production structure (Section 2.6.3). Lifting these assumption would not change the basic results, but it would decrease the flexibility and tractability of the model.

2.6.1 Price Competition

In the model described in Section 2.4 firms were engaging in Cournot competition. However, competition in quantity might not apply to every case. For instance, we can imagine that suppliers bid for a unit wholesale price and then quantity is picked based on the lowest offer. By reciprocally undercutting each other even a small number of competitors might drive supplier's profits to zero. Price competition might also arise when the quantity provided is fixed by other components of the supply chain. For instance, in the presence of a final good produced by assembling smaller parts, the marginal cost of the final product might be overwhelmingly driven by one of these parts. The quantity demanded of all other components will be set by the availability of the most costly and competition would be in prices.

A Cournot oligopolistic dynamic can approximate the results of a price competition à la Bertrand for the ranking of firms' surplus shares. Bertrand competition, in fact, speeds up the convergence of absolute profits to the perfectly competitive results for absolute profits: only two firms are necessary for profits to go to zero. Nevertheless, our policy results of Section 1.5 are not based on absolute profits but on the rankings of profit shares (firms' profits over total surplus). These rankings are independent of the type of competition. For instance, in a Producer Driven scenario, if stage one of production is a monopoly and stage two is a duopoly, profits shares at stage one are going to be strictly greater than profit shares at stage two independently of the type of competition considered. If both stages are duopolies, instead, in both cases profit shares at stage one are going to be greater or equal to the profit shares at stage two. In a Cournot scenario they are going to be strictly greater, while in a Bertrand scenario they are going to be weakly greater: they are both going to be equal to zero. Bertrand competition would not alter our policy results. It would complicate the analysis by creating discontinuities where we now have continuous, well-behaved and very tractable functions.

If the Bertand game is repeated, collusion can arise. Collusion will drive wholesale prices upward. However, collusion is increasingly difficult as the number of supplying firm increases because the incentive to deviate and capture the entire market is higher. In a repeated price competition game, the number of competitors per stage, even when greater than two, plays a part in firms' final surplus shares, like in the results of our model.

2.6.2 Endogenous Length of the Value Chain

The underlying assumption in Section 2.4 was the presence of a GVC with a fixed structure: the number of stages of production was fixed and so was the number of firms that compete at each stage of production. GVCs are fluid production networks that find in that flexibility their comparative advantage. Firms can easily engage or disengage with their suppliers as market conditions change.

Our final results do not account for changes in the structure of the value chain in response to policy changes. Appendix B shows that concentration naturally accrues at the lead firm stage of the value chain, exacerbating the concentration of surplus at those stages of production and strengthening the implications for development policies presented in Section 1.5.

Appendix B shows the vertical integration trends for a BD value chain with two intermediary stages. When the downstream stage is perfectly competitive, upstream firms with market power always have an incentive to buy downstream firms and internalize production as that will increase their profits. When upstream stages are perfectly competitive, downstream firms do not experience any increase in profits when they buy upstream firms. Intuitively, in a BD value chain downstream firms enjoy two sources of markup: the ability to act as monopolists with respect to downstream actors and the ability to act as monopsonists on upstream firms. Upstream firms, instead can only act as monopsonists as they lack relevant information about downstream markets. Buying off perfectly competitive upstream firms means buying off firms that are selling at cost. Buying off downstream firms, instead, creates the opportunity to acquire an extra level of market power. For the same reason, when both production stages are occupied by a monopolist, both firms have an incentive to buy the other one. However, the upstream firms always have a greater incentive to buy downstream firms.

Market power concentrates at the downstream end in a BD value chain and at the upstream end in a PD value chain, strengthening the policy implications discussed in Section 1.5.

2.6.3 Non-linear Value Chain

GVCs can assume multiple and more complicated shapes (Baldwin and Venables, 2013). This section discusses the linearity assumption by extending the model of Carnovale (2018) to simulate the effects of the same types of development policies discussed in this paper.

In Carnovale (2018) a set of consumers enjoys a variety of products they can purchase at a given retailer with their limited budgets. This limited budget forces them to make trade offs among goods based on the prices of all alternative options.

Retailers are undifferentiated: they all offer the same products at the same prices. They outsource production to independent suppliers. Each good is manufactured by at least one supplier, but not necessarily only one allowing for competition at the supplier level.

We extend that model to allow for more than two stages of production: (a variable number of) retailers sell partially substitutable items to consumers and production of each item is outsourced to suppliers. The production of each item requires multiple components, partially substitutable and supplied by different producers. Each of these components requires the assembly of multiple parts whose production is also outsourced. The chain of production has K stages, with K finite. When passing each item from one stage of production to another, firms incur in a transportation cost. The final profits of each supplier are, thus, subject to competitive pressure on three dimensions: horizontal competition; vertical competition and "across-product" competition. The latter is induced by product varieties and assembly parts competing over the limited budget of the final consumers.

The model shows that, even with a complex value chain structure, an upstream decrease in trade costs makes firms worse off in relative terms, while a downstream decrease in trade costs makes firms gain in relative terms. An upstream and a downstream increase in competition makes a firm better off, but the impact of the increase in competition depends on the initial levels of competition. An increase in the elasticity of demand, driven by an increase in the degree of substitutability among product varieties increases the relative profits for upstream firms, but not for downstream firms. These results are very much consistent with the results of Section 1.5 for the Producer Driven model.

Further details about the adaptation of the model of Carnovale (2018) and the final results on policy outcomes can be found in Appendix C.

2.7 Conclusions

This paper provides an analytical framework to evaluate trade-based and industrial development policies. This framework mathematically formalizes some of the basic features of value captured within GVCs: the contributions of both horizontal and vertical levels of competition (GVC governance) in influencing surplus distribution between producers, consumers and intermediary firms. Vertical competition overwhelmingly drive profits towards the leader of the chain: the upstream firm in a Producer Driven value chain and the downstream firm in a Buyer Driven value chain. Horizontal competition can partially offset that trend or exacerbate it, depending on the patterns of industry concentration.

Policies conclusions from a simple model should be taken with caution and the analysis proposed certainly has limitations. Nevertheless, we have shown that results are robust to alternative specifications of the structure of the value chain and the competitive dynamic.Results are also consistent with the empirical GVC literature, the international trade literature and basic economic intuition. As such, this formal and flexible framework proves itself effective at organizing different contributions within and across literatures on value captured within value chains. It informs a clear thinking on the effect of development policies in these settings.

The model shows that the position of firms along the value chain affects the degree with which they benefit from certain policies. Most of the extra surplus induced by policies flows towards firms with higher levels of information and bargaining power. A decrease in trade cost benefits firms relatively more if the change happens downstream in a Producer Driven model and upstream in a Buyer Driven model. An upstream increase in horizontal competition benefits firm relatively more than a downstream increase in a Producer Driven model, while the contrary is true for a Buyer Driven model. A steeper demand benefits firms in a Producer Driven model, but not in a Buyer Driven model, while the contrary happens in the presence of a steeper supply.

Considering GVCs governance appears crucial to design effective policies. This intuition helps explaining the inconsistency in outcomes when similar policies are pursued in different countries (Baldwin and Venables, 2015; Rodrik, 2016). Industry characteristics alter the effectiveness of policy interventions. The benefits of economic growth policies can spill over and benefit countries other than their target.

The results suggests ways to prioritize policies when countries have limited resources for growth-inducing measures. For instance, if the proposed beneficiary country appears to benefit from a greater engagement within a BD industry, decreasing import duties on inputs rather than export duties on outputs would be most beneficial. In the former case more of the associated increase in aggregate surplus would stick the the target country. The contrary would be true in a PD industry.

This framework has also implications for thinking about adjusting policies to changes in the context. For instance, strong consolidation in the grocery store industry has taken place in the last couple of decades both in Europe and the United States (Hong and Li, 2017). That shift will alter not only profit distribution, but also the effectiveness of development policies in countries that supply those retailers. Other changes are more political in nature, especially in this time of resurgence of trade protectionist measures in the west, accompanied by the trade facilitation arrangements of China's Belt and Road Initiative. These changes will shift the distribution of resources among countries and alter the effectiveness of development policies in a way that the propose framework can help predict.

Future work should go into empirically validating the results and implications of this analytical framework. However, empirical studies are always imperfect, especially in studying GVC where the limited availability of fine-grained data hampers policy action. We believe that in a context where empirics are difficult, a theoretical model can partially substitute. The analytical model provided effectively organizes and replicates empirical evidence on value captured within GVCs and as such can provide insights on important policy questions. It can direct further empirical work, but also guide policy experimentation that is better aligned with development goals.

Chapter 3

Who Pays for Labor and Environmental Standards? The influence of product substitutability on the bargaining power between retailers and suppliers.

While there is evidence that production networks serving highly regulated markets can transmit labor and environmental standards (LES) to under-regulated regions, the cost distribution of complying with LES is sorely understudied. This paper provides a theoretical model of multi-product retailers selling partially substitutable goods and outsourcing production to upstream suppliers. It investigates the effects of labor and environmental standards driven by consumers: under what conditions do they result in an uneven distribution of effort, and hence cost of compliance, between producers and retailers? Results show that when products are highly substitutable a multi-product retailer can shift the cost of compliance with LES on to its suppliers. A single-product retailer would not be able to completely shift those costs on to suppliers. Product substitutability drives the result as a change in product characteristics affects demand of its substitutes: a source of bargaining power for a multi-product retailer. Product substitutability could lead well-meaning LES to exacerbating producers vulnerability.

3.1 Introduction

Can labor and environmental standards (LES) shift industry profits from upstream suppliers to downstream multi-product retailers? While there is evidence that production networks serving highly regulated markets can transmit LES to under-regulated regions, the cost distribution of complying with those standards is sorely understudied. The current wave of globalization has included many developing countries into the global economy. However, it has also increased the vulnerability of many of their firms. Regulations and production standards can exacerbate this vulnerability, contributing to the diverging economic performance of high- and low-income countries (Bolwig et al., 2013; Dolan and Humphrey, 2000; Kaplan and Kaplinsky, 1999; Ponte and Gibbon, 2005; Neilson, 2008; Cafaggi and Renda, 2012).

This paper investigates the effects of LES driven by consumer demand: under what conditions do they result in an uneven distribution compliance costs between suppliers and retailers? I provide a theoretical model of multi-product retailers selling partially substitutable goods and outsourcing production to upstream suppliers. Results show that when products are highly substitutable a multi-product retailer can shift the cost of compliance with LES on to its suppliers. A single-product retailer is unable to do that. Product substitutability, in fact, drives the result as a change in product characteristics affects the demand of its substitutes: a source of bargaining power for a multi-product retailer.

Multi-product retailers are now uncontested leaders in many consumers markets (think of Amazon or Wal-Mart). Their pricing strategies (Rochet and Tirole, 2003; Weinstein and Ambrus, 2008; Chen and Rey, 2012) and ability to regulate their production network (Boudreau and Hagiu, 2009) are widely studies. However, limited attention has been given to the development implications of their market power and how it interacts with LES. This paper highlights the interplay between bargaining power and LES as mediated by industry characteristics (product substitutability) and market structure (multi-product versus single product retailers).

As a broader contribution to the policy debate on accountability mechanisms for multinational firms, this analysis shows that product substitutability and the nature of the downstream outsourcing retailer affect the distribution of LES compliance cost. Data limitation restricts empirical studies on the effects of industry and trade structure, hence the importance of theoretical work. Policy makers and consumers should be cognizant of these interactions as they can lead LES to increase the vulnerability of producers in the developing world.

This paper speaks to the literature on how trade influences environmental practices and regulation in exporting countries. Early theories of globalization suggested that the competitive advantage granted by the absence of environmental standards would sink regulation in producing countries (Cherniwchan et al., 2016; Rodrik, 1998; Eskeland and Harrison, 2003). However, empirical evidence rejected the hypothesis. On the contrary, globalization boosted environmental standards in many countries, even when not supported by formal regulation.

The saliency of labor and environmental concerns in high-income consumption markets drives the international transmission of LES standards. Multinationals have the incentive to impose LES on suppliers in their production networks to protect the value of their brands (Vogel, 1995; Greenhill et al., 2009; Garcia-Johnson, 2000; Perkins and Neumayer, 2012; Prakash and Potoski, 2007, 2006; Poulsen et al., 2016). They also have the bargaining power to effectively enforce them. Compliance is influenced by countries institutional characteristics as well as lead firms governance (Distelhorst et al., 2015, 2016; Locke et al., 2009; Locke and Romis, 2010; Poulsen et al., 2016) stressing the role of offshoring firms in diffusing sustainable production globally (Lambin et al., 2018).

Empirical evidence also shows that transmission of LES can exacerbate the vulnerability of small-scale producers in developing countries (Dolan and Humphrey, 2000; Kaplan and Kaplinsky, 1999; Ponte and Gibbon, 2005; Cafaggi and Renda, 2012). This paper outlines a mechanism that synthesises both sets of empirical evidence.

The mathematical model proposed captures the influence of product substitutability on the bargaining power of a multi-product retailer over its suppliers. Consumers love variety and shop at multi-product retailers. Multi-product retailers sell partially substitutable goods and outsource production to upstream suppliers. Suppliers are independent and only produce one good. Consumers boycott products that do not meet LES.

Results show that when products are complementary (low elasticity of demand) suppliers have bargaining power and most of the compliance costs are absorbed by the retailer. As products get more and more substitutable, suppliers bargaining power erodes and a multi-product retailer can shift compliance costs on to its suppliers. Unable to leverage product substitutability, a single-product retailer cannot completely shift those costs.

This model provides a framework for industrial policies. Governments in producing countries might want to provide financial support for environmental compliance to local producers of substitutable goods destined to export markets. Instead, market dynamics would drive development when the produced goods have low level of substitutability.

Policy implications are important given current trends in the retail industry. International trade is dominated by trade in intermediates and most of it takes place within the production networks of multinationals (Antras, 2003; Miroudot et al., 2009; OECD, 2013). At the same time, consolidations in the retail industry increases their bargaining power elevating retail giants as price setting intermediaries (Hong and Li, 2017). These trends raise questions on the ability of suppliers to bargain over profitable market conditions. Policy design can mitigate distributional issues.

3.2 Previous Literature

The debate on the relationship between LES and international trade used to be dominated by the Pollution Heaven Hypothesis. Countries specialize in the production of clean or dirty goods depending on their comparative advantage (Cherniwchan et al., 2016). The leniency of regulation can itself become a source of comparative advantage creating a "race to the bottom" in LES among countries (Rodrik, 1998). However, there is little evidence in support.

Most production processes are conducted within GVCs[1]. Many high-value con-

[1]Final sale in developed countries is often facilitated by multi-product retailers that connect producers and consumers. Ruggie (2017) reports that in 2014 the Apple iPhone 6 was assembled using products sourced from 785 suppliers in 31 countries. Many of those suppliers where themselves multinational firms, who outsourced their production to foreign firms. Similar trends are outlined for companies such as Disney, Wal-Mart and major apparel brands (Vogel, 2007). Not only production is sliced up in geographically dispersed tasks, but it also constantly moves in search of lower costs locations (Feenstra, 1998) making production processes opaque and costly to monitor.

suming markets require LES to be embedded in the product. Through this mechanism a "race to the top" in labor and environmental regulation is possible: under-regulated countries have an incentive to converge to the standards of highly regulated ones, as long as those highly-regulated jurisdictions are important markets for their exports (Vogel, 1995). Thus, while globalization can pressure LES downward, demand pressures it upward. Consequently, enhancing trade ties with developed nations can improve labor rights in low- and middle-income nations (Greenhill et al., 2009). Thanks to their strong market power, platforms (retailers of a large variety of diversified products) are regulators within their own ecosystem, imposing various types of standards (Boudreau and Hagiu, 2009) and facilitating LES spillovers.

LES enforcement is facilitated by multinational firms. Many multinationals have developed codes of conduct and supply chain standards. As multinationals extend 'best-practices' to their trading partners, those practices are often adopted in the whole economy (Garcia-Johnson, 2000). These positive spill-overs have been documented for environmental and labor standards. For instance, Perkins and Neumayer (2012) find that countries exporting automobiles and related components to locations with more stringent auto-emission standards are associated with more stringent domestic regulation and that foreign direct investments into developing countries are more common when more stringent regulation is enforced in the receiving country. Greenhill et al. (2009) show that labor laws and practices are influenced by those of the export destinations. These studies confirm for public standards the same effects documented for private standards.Prakash and Potoski (2007, 2006) show positive effects on adoption of the voluntary environmental production standards ISO 14001. Garcia-Johnson (2000) finds that commercial ties between the US and Brazil or Mexico spread environmental standards in the chemical industry.

Consumer standard influence firms practices. Brand power has increased in significance and scope, but it is also vulnerable to the negative press of poor labor or environmental practices. In the 1990s activists exposed poor working conditions and child labor in the manufacturing facilities where Nike had outsourced production. After denying responsibility on the grounds that they did not have direct control over their independent suppliers, Nike faced a negative backlash. "The Nike product has become synonymous with slave wages, forced overtime, and arbitrary abuse," Phil Knight, Nike's CEO, said in May 1998 "I truly believe the American consumer doesn't want to buy products made under abusive conditions." Nike managed to save its reputation by becoming an industry leader in fair labor standards, increasing disclosure and imposing voluntary safe-labor and clean-air policies along its supply chain. Its prominent role in the industry compelled competitors to do the same (Niesen, 2013; Locke et al., 2007).

In 2010 Wal-Mart announced a plan towards a greener supply chain. They voluntarily cut 20 million metric tons of emissions in 5 years by targeting staple goods and by pressuring suppliers to rethink their own sourcing, transportation and packaging practices. Wal-Mart said supplier participation in the program was not mandatory, but that the giant retailer was interested in doing business only with suppliers that shared its environmental goals. This process is not driven by formal legal responsibility over the labor practices of its independent suppliers, but by the demands of its stakeholders. As large companies get increasingly under the public scrutiny and consumers are interested in ethical consumption, many multinationals have developed code of conducts and standards of operations to ensure ethical practices within their supply chains. When multinational buyers extend their best-practices to their trading partners, those practices are often adopted in the whole economy (Garcia-Johnson, 2000). This has brought attention to and enthusiasm over the role of multinational companies' production networks as a mean to increase welfare (Lambin et al., 2018).

Not much of this literature, however, focuses on the issue of distributional conflicts between outsourcing and producing firms. However, there is a vast industrial organization literature on how governance dynamics between upstream and downstream firms affect their rent distribution (Rey and Tirole, 1986; Rey and Vergé, 2010) and cost pass-through (Nakamura, 2008; Nakamura and Zerom, 2010; Gopinath and Itskhoki, 2010; Gopinath et al., 2010, 2011; Goldberg and Hellerstein, 2008; Burstein and Jaimovich, 2009). Horizontal and vertical competition have independent effects on cost pass-though. Firms with larger market shares have lower cost pass-through (Atkeson and Burstein, 2008; Auer and Schoenle, 2016; Amiti et al., 2014) as they are able to transfer costs shocks more effectively on their suppliers. Similarly, vertically disintegrated production decreases rates of cost pass-through consistently with an increase in double marginalization (Neiman, 2010, 2011; Hellerstein and Villas-Boas, 2010). Tariff pass-through is influences by horizontal competition in the presence of homogeneous goods (Iapadre and Pace, 2016).

Products' substitutability also affects the pass-through of a tax. The pioneering model of platforms was introduced by Rochet and Tirole (2003). It describes retailers of diversified products who belong to a two-way market. Think of Amazon.com or App Stores whose business model consists of providing consumers with a large menu of options and producers with a diversified market to serve, setting themselves as the crucial intermediary in between (Boudreau and Hagiu, 2009; Sriram et al., 2015). This line of research investigates the pricing strategies of platforms, especially prices to access the service. It identifies a loss-leader and a profit-center: the platform shifts most costs on one side of the market, either supply or demand, depending on industry characteristics (Rochet and Tirole, 2003; Weinstein and Ambrus, 2008; Chen and Rey, 2012). Platforms are also found to diminish the impact of taxes on consumer prices, while the burden of the tax shifts on upstream producers (Kind et al., 2010).

Ever since the seminal contribution of Gereffi (1994, 1999b), the Global Value Chain literature saw in the offshoring economy and the governance structure of GVCs a channel to increasing income disparities between the North and the South of the World. By recognizing that lead firms are most often located in developed countries, while upstream producers are located in the developing world, the GVC literature draws a connection between GVC governance and economic development (Mudambi, 2008, 2007; Milberg and Winkler, 2013; Kaplinsky, 2000).

Within this literature, production standards are characterized as barriers to entry in high-value markets that affect value chain structure and governance[2].

Gobal private regulation can also shift the bargaining power among firms resulting in a reallocation of the industry profits. Consumer driven standards in the fishing industry concentrate market power at the retailer level. In fact, it increases salience of product attributes for producers that are already locked into the relationship with large buyers. Thus, it decrease upstream producers' bargaining power and industry profits shift towards downstream firms (Ponte and Gibbon, 2005). Similar results hold for Indonesian small-holder coffee producers (Neilson, 2008). Cafaggi and Renda (2012) show that the agricultural certification program Global G.A.P. imposes most of its costs on producers in developing countries. The implication is that private standards tend to reallocate profits towards downstream lead firms, often located in the developed world.

[2]For instance, Bolwig et al. (2013) show that product or production standards do not benefit low-income countries' as they create technical barriers to trade, economies of scale and scope and do not translate into sufficiently higher price premiums. Additionally, they limit inclusion into the export oriented economy. Dolan and Humphrey (2000) show that the high phytosanitary and environmental standards, the required predictability of product characteristics as well as the quality necessary to appeal to the European consumer, create barriers to entry for producing farms in Kenya and Zimbabwe. Kaplan and Kaplinsky (1999) document that EU legislation protecting domestic farmers inflated the competitive advantage of Southern European producers of canned fruit at the expenses of their South African competition.

This paper provides a mathematical formalization of the aforementioned empirical literature. It investigates how consumer-driven standards protecting labor or the environment affect bargaining power, hence profits, of firms involved in GVCs.

3.3 A Model of Consumer Driven Standards

3.3.1 Intuition

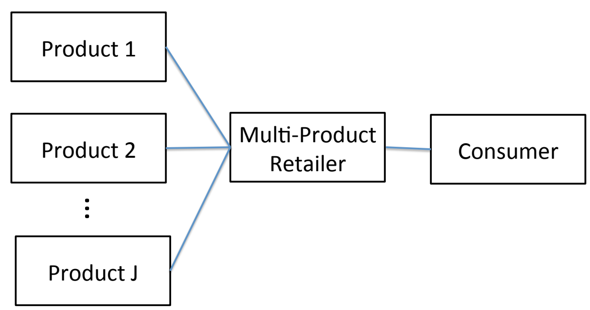


Figure 3.1: Competition among value chains for three products provided to consumers

Consumers like a variety of products they can purchase from a given retailer. However, on top of enjoying those products, they care about LES: they want environmentally sustainable or fair-labor practices to be embedded in the products. They divide their limited income over the available products according to their relative price, the degree of product substitutability and their valuation of LES attributes. This valuation depends on the observability of LES characteristics. If consumers do not observe LES compliance they are not going to adjust their demand accordingly.

Retailers are undifferentiated: in equilibrium they all sell the same products at the same price. They outsource production to independent suppliers. Each supplier produces only one good, but there are multiple suppliers per product. Firms' final profits are driven by horizontal competition; "across-product" competition (influenced by perceived LES quality); and vertical competition. Horizontal competition is the competition between identical firms at the same stage of the value chain. Imagine the competition between Jiff and Skippy over the sales of peanut butter or the competition between Wholefoods and Trader Joes in attracting consumers. "Across-product" competition is the competition between different products over the limited budget of the consumers. Imagine a trip to a store: the decision on what products to buy and what products to leave on the shelf is going to be determined by price and individual preferences. Vertical competition is the competition between suppliers and retailers over the surplus created by the final sale of the product.

These three levels of competition determine mark-ups optimally set by suppliers and retailers on wholesale and retail prices. Mark-ups are lower the more substitutable products are, as in a monopolistic competition setting, because the final demand for substitutable products is more elastic. Mark-ups decrease with the number of horizontal competitors, as in the Cournot oligopolistic competition. The level of perceived LES compliance does not influence mark-ups.

Perceived LES compliance increases demand. An increase in perceived LES compliance embedded in the products (either an increase in the actual attribute or an increase in its visibility) increases both retailers' and suppliers' profits through its positive effect on quantities. However, it affects them differently. Suppliers' profits are positively affected by the increased in LES perceived compliance. The profits of the retailer are subject to two opposing forces. The first one is a positive effect on profits of the LES complying product. The second is the negative effect on every other product sold, whose quantity decreases as their relative LES perceived compliance decreases. This second effect mitigates the first one and it is stronger for highly substitutable products.

When products are highly substitutable, suppliers' bargaining power decreases because they are subject to relatively more competitive pressure (the "across-goods" component). Multi-product retailers shift LES compliance costs on to their suppliers. A single product retailer would not be able to shift those costs.

3.3.2 Model

Imagine a Global Value Chain with two stages as in Figure 2.1. There are $N_j \in [1, \infty)$ identical suppliers ($i \in [1, N_j]$) for each product $j \in [1, J]$ who sell their output to $R \in [1, \infty)$ identical downstream retailers ($r \in [1, R]$). Retailers sell all J products without specializing or differentiating their offering in terms of price or quantity.

The J products differ in terms of LES compliance: to each product j is attached a level of LES compliance $z_j \geq 1$. Consumers value the LES quality embedded in a good, but they can discriminate between low and high quality only if they observe it. LES observability is $\gamma \in [0, 1]$: the higher γ, the more observable LES compliance is.

3.3.2.1 The Consumer Problem

The representative consumer's utility function becomes:

$$U = \sum_{k=1}^{J} z_k^{\gamma} q_k^{\rho} \tag{3.3.1}$$

Consumers need to maximize utility function (3.3.1) subject to budget constraint $Y = \sum_{k=1}^{J} p_k q_k$. The quantity consumed of each product j follows from this maximization problem and is higher the higher its LES quality, but only if observable, as shown in equation (3.3.2) and Figure 3.2. However, the effect of observable quality on demand is higher the more substitutable products are. The relationship between demand, own price and income remains the same as equation (4.2.2). The impact of the price of every other good on demand is also going to be weighted by the observable product quality of every good suggesting that consumers not only compare prices, but also LES characteristics when purchasing their products.

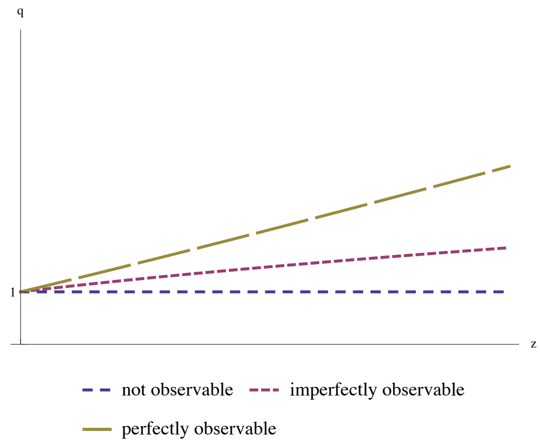
Consumers need to maximize utility function (3.3.1) subject to budget constraint $Y = \sum_{k=1}^{J} p_k q_k$. The demand for each product j follows from this maximization problem. It is higher the higher its LES quality, but only if observable, as shown in equation (3.3.2) and Figure 3.2. The effect of observable quality on demand is higher the more substitutable products are. Demand of j is increasing with income and the price of every other good (within G, the price index). Demand of j is decreasing with own price and perceived LES quality of every other good (again within the G term). These effects are stronger the more substitutable products are.

$$q_j = \frac{Y}{G} p_j^{\frac{1}{\rho-1}} z_j^{\frac{\gamma}{1-\rho}} \tag{3.3.2}$$

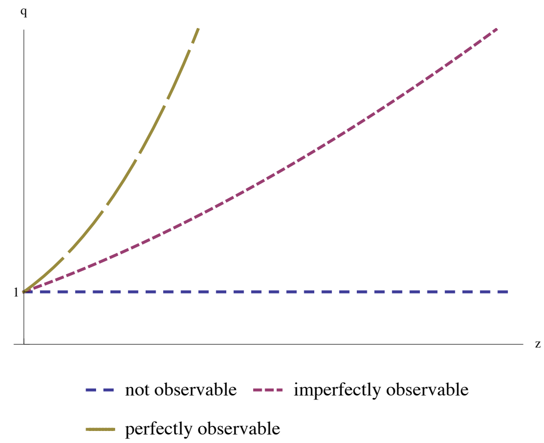
$$G = \sum_{j=1}^{J} p_j^{\frac{\rho}{\rho-1}} z_j^{\frac{\gamma}{1-\rho}} \tag{3.3.3}$$

3.3.2.2 The Retailer Problem

Retailers are aware of market demand for each product. They collect revenues over all products, but need to pay a wholesale price g_j for each good j as well as a fixed



(a) Complementary products: $\rho = 0.1$



(b) Substitutable products: $\rho = 0.7$

Figure 3.2*:* Demand as a function of own LES quality as of equation (3.3.2)

cost of operating F[3]. Their final profits are represented by equation (3.3.4).

$$\pi_r = \sum_{j=1}^{J} p_j q_{r,j} - g_j q_{r,j} - F \tag{3.3.4}$$

The total quantity of good j sold to consumers q_j is the sum of sales made by all retailer: $q_j = \sum_{r=1}^{R} q_{r,j}$. The quantity sold by each retailer is equal to the difference between total quantity on the market and the quantity sold by every other retailer.

$$q_{r,j} = q_j - \sum_{s \in [1,R]/r} q_{s,j} \Leftrightarrow q_{r,j} = \frac{Y}{G} p_j^{\frac{1}{\rho - 1}} - \sum_{s \in [1,R]/r} q_{s,j} \tag{3.3.5}$$

Retailers are identical and compete à la Cournot. Retailer's maximisation problem (3.3.6) yields optimal pricing as in equation (3.3.7). Optimal retail price depends on g_j, the wholesale price. Retailers apply a markup $\beta_r \in [1, \infty)$. The more substitutable the goods, the lower the markup. In the limit, retailers sell at cost. The lower the competition on the retail market (the lower R), the higher the markup.

[3]The underlying assumption is that F is too high for each supplier to sell directly to the consumers

$$\begin{aligned} \underset{p_1,\ldots,p_J}{\text{maximize}} \quad & \pi_r = \sum_{j=1}^{J} p_i q_{r,i} - F \\ \text{subject to} \quad & q_{r,j} = \frac{Y}{G} p_j^{\frac{1}{\rho-1}} - \sum_{s\in[1,R]/r} q_{s,j} \end{aligned} \tag{3.3.6}$$

$$p_j^*(g_j) = \frac{\frac{1}{\rho-1}}{\frac{\rho}{\rho-1} - \frac{R-1}{R}} g_j = \beta_r g_j \tag{3.3.7}$$

This price structure replicates the main results from monopolistic and Cournot competition:

1. When goods tend towards perfect substitutability, there is no mark-up for the retailer who sells at cost, independently of the level of competition: $\lim_{\rho\to 1} p_j = g_j$

2. When the retailer market is a monopoly, the markup depends on the degree of substitutability. The markup for complementary goods will be higher than for substitutes: $\lim_{R\to 1} p_j = \frac{1}{\rho} g_j$. These result replicate the traditional result of monopolistic competition.

3. When retailers operate under perfect competition, there is no markup and the each retailer sells at cost ($\lim_{R\to\infty} p_j = g_j$)

3.3.2.3 The Supplier Problem

Each supplier $i \in [1, N_j]$ of good j is informed about market demand and optimal pricing strategy by the retailers. They produce variety j at cost c_j and sell it to the retailers at wholesale price g_j for total profits $\pi_{i,j} = (g_j - c_j)q_{i,j}$. Total quantity sold by supplier i of good j is equal to the difference between the quantity demanded by the retailers and the quantity provided by every other supplier of the same variety. The

N_j identical suppliers compete in quantities over consumer demand. They maximize their profits (optimization problem (3.3.8)) setting optimal price given by equation (3.3.9). As for equation (3.3.7), the optimal price depends on the unit cost of production c_j and a markup β_j. The mark-up decreases with product substitutability and with N_j.

$$\begin{aligned} \underset{g_j}{\text{maximize}} \quad & \pi_{i,j} = (g_j - c_j)q_{i,j} \\ \text{subject to} \quad & q_{i,j} = \frac{Y}{G}(\beta_r g_j)^{\frac{1}{\rho-1}} - \sum_{s\in[1,J]/i} q_{s,j} \end{aligned} \tag{3.3.8}$$

$$g_j^*(c_j) = \frac{\frac{1}{\rho-1}}{\frac{\rho}{\rho-1} - \frac{N_j-1}{N_j}} c_j = \beta_j c_j \tag{3.3.9}$$

Optimal final price to consumers is equal to equation (3.3.10). Optimal final demand is given by equation (3.3.11). The profits of retailers and suppliers in equilibrium (equation (3.3.13) and (3.3.12)) follow from these equations.

$$p_j^*(c_j) = \beta_r g_j = \beta_r \beta_j c_j \tag{3.3.10}$$

$$q_j^*(c_j) = \frac{Y}{G}(\beta_r \beta_j c_j)^{\frac{1}{\rho-1}} \tag{3.3.11}$$

$$\pi_{i,j}^* = (\beta_j - 1)c_j(\frac{Y}{G}(\beta_r \beta_j c_j)^{\frac{1}{\rho-1}} z_j^{\frac{\gamma}{1-\rho}}) \tag{3.3.12}$$

$$\pi_r^* = \sum_{k=1}^{J}(\beta_r - 1)\beta_k c_K(\frac{Y}{G}(\beta_r \beta_k c_k)^{\frac{1}{\rho-1}} z_k^{\frac{\gamma}{1-\rho}}) \tag{3.3.13}$$

A double marginalization problem arises whenever goods are less than perfectly substitutable and when the retailer or the supplier markets are not perfectly competitive. Under these circumstances, both retailers and suppliers are going to charge a mark-up, making the final price higher than that of vertically integrated firms. This depresses demand and total industry profits compared to a scenario of vertical integration. The double marginalization problem is addressed in Appendix E: an alternative model is presented where suppliers and retailers share the optimal profits under vertical integration.

3.3.2.4 Relative Compliance Effort

Compliance effort takes two forms. For a given level of LES quality (z_j), firms can invest on its visibility (γ) for instance though a certification or labelling program. Alternatively, for a given level of observability firms can upgrade LES quality, for instance by investing in a cleaner production technology. This section focuses on first one while Appendix F will outline the second case showing that it yields the same results in terms of relative compliance effort on the part of the retailers and suppliers.

Firms pick their optimal compliance effort which are bounded between 0 and 1 ($e_{i,j} \in [0,1]$, $e_{r,j} \in [0,1]$). They set optimal effort that maximizes their profit given the cost of effort, which is determined by the functions $R(e_{r,j})$ and $S(e_{i,j})$ for retailers and suppliers respectively. Costs are increasing in own effort. LES observability γ is a function of retailers' and suppliers' effort, as in equation (3.3.14) where $a\,b \geq 1$. As in Figure 3.3 $\Gamma(e_{i,j}, e_{r,j})$ is bounded between 0 and 1. As the effort of one actor increases, gamma increases, but at a decreasing rate. Both suppliers and retailers benefit from increasing LES observability as it increases demand, but they would prefer not to incur in its cost.

$$\Gamma(e_{i,j}, e_{r,j}) = 1 - \gamma((1 - e_{r,j})^a + (1 - e_{i,j})^b) \tag{3.3.14}$$

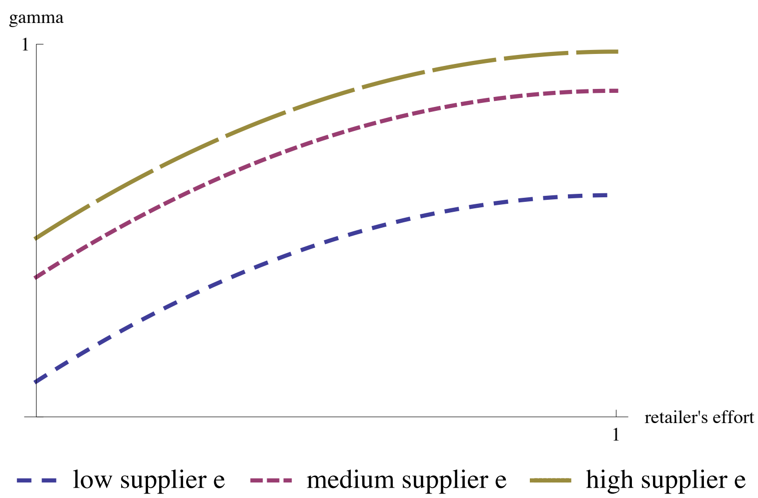


Figure 3.3: LES Quality Observability Function $\gamma(e_{i,j}, e_{r,j})$ *This figure graphs equation (3.3.14) for values:* $a = b = 2$ *and* $\gamma = 1/2$.

Firms maximize their profits with respect to own effort.

$$\underset{e_{i,j}}{\text{maximize}} \quad \pi_{i,j}(e_{i,j}) - S(e_{i,j}) \tag{3.3.15}$$

$$\underset{e_{r,j}}{\text{maximize}} \quad \pi_r(e_{r,j}) - R(e_{r,j}) \tag{3.3.16}$$

Appendix D.1 describes the derivation of relative compliance effort function of equation (3.3.17).

$$\frac{(1 - e_{i,j})^{b-1}}{(1 - e_{r,j})^{a-1}}\Big|_{CS} = \frac{a}{b}\frac{\partial_{e_{i,j}} S(e_{i,j})}{\partial_{e_{r,j}} R(e_{r,j})}\frac{N_j}{R}\Big(\frac{(\beta_r - 1)\beta_j}{\beta_j - 1} - \frac{(\beta_r\beta_j c_j)^\rho}{(\beta_j - 1)c_j}(1 - \frac{1}{\beta_r})\Big) \tag{3.3.17}$$

3.4 Results

This section will present a step by step derivation of the main result of this model. As product substitutability increases (as the elasticity of demand increases), the bargaining power of multi-product retailer increases. They can leverage the across-product competition created by product substitutability to shift most of the cost of LES compliance on to their suppliers. A single product retailer would not be able to shift those costs on to suppliers because it is subject to the across-product competition too.

Proposition 3.4.1. *The gross profits of the retailers on each product are greater than the profits of its suppliers as long as there are at least as many suppliers as retailers:* $\pi_{r,j} > \pi_{i,j} \iff N_j \geq R$.

Given a level of ρ, which is an attribute of the product, when there are more suppliers than retailers the mark-up for the product is higher for the latter. Additionally, this results shows than even when there are the same amount of suppliers and retailers, the gross profits for retailers are higher, suggesting that even in a setting where all actor are perfectly informed and are subject to the same degree of horizontal and "across-product" competition, vertical competition favors downstream firms. Proof of this proposition is going to be provided in Appendix D.2.

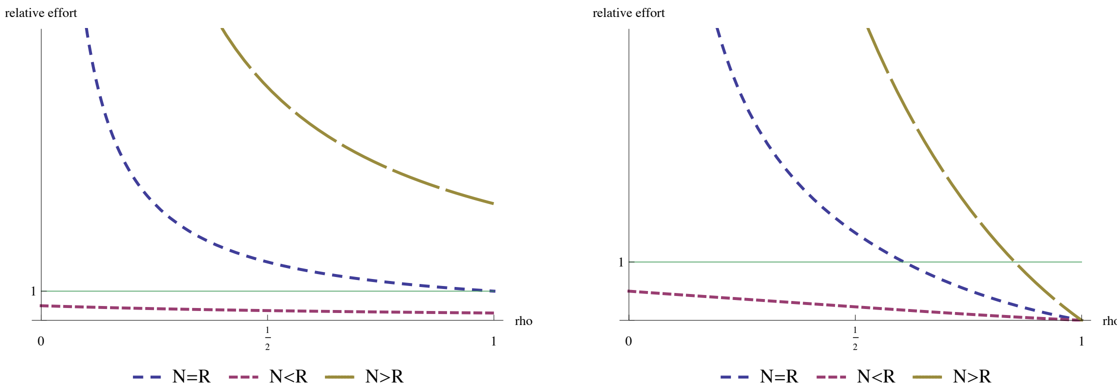
Proposition 3.4.2. *For each product j, the impact of a standard on product j imposed on the retailer is always greater on the retailer than on the supplier as long as* $N_j \geq R$. *However, this effect is mitigated by the effect on the profits on every product other than j. This second effect is stronger the more substitutable products are.*

LES impact retailers' and suppliers' profits through its effect on demand, not mark-ups. Assuming that there are as many suppliers as retailers for good j ($N_j = R$), the effect on the quantities sold of good j is the same for both suppliers and retailers. However, retailers make more profits out of the sale of each unit of j than suppliers do, so their gross profits on product line j increase more. The process is accentuated if the horizontal competition is stronger at the supplier level ($N_j > R$), as the effect of LES on quantities shrinks for the suppliers relative to the retailers. Nevertheless, when retailers sell more than one product, higher LES quality on one product decreases demand of every other product. This effect is greater the more substitutable products are, as demand is more responsive to price. It mitigates the positive effect on product j profits. Formal proof is given in Appendix D.2.

Proposition 3.4.3. *Compliance effort of the retailer is lower than compliance effort of the supplier for highly substitutable goods, and higher for goods with low substitutability, as long as the retailer sells multiple products and as long as* $N_j \geq R$, $\partial_{e_{i,j}} S(e_{i,j}) \geq \partial_{e_{r,j}} R(e_{r,j})$, $a \geq b$. *Compliance effort of a single-product retailer of j is greater than compliance effort of the supplier for all values of* ρ, *even though their difference decreases as goods are more substitutable.*

Proposition 3.4.3 follows directly from Proposition 3.4.2. Since the impact of LES quality j is stronger on the multi-product retailer than the supplier of good j for low levels of substitutability, the retailer will have a stronger incentive to invest in an activity that will improve LES quality or observability. Nevertheless, that decreases relative LES perceived quality of every other product. Demand decreases for every other product and it does it faster when product are very substitutable (ρ close to 1). That mitigates the effect of LES perceived quality on multi-product retailers' profits. Consequently, relative compliance effort $\frac{(1-e_{i,j})^b}{(1-e_{r,j})^a}$ drops too. Compliance effort of the suppliers matches and surpasses that of the retailers.

This effect is due to the ability of the retailer to leverage the competition "across-products" to its advantage. Across-product competition is stronger for substitutable



(a) Single product retailer

(b) Multi-product retailer

Figure 3.4*:* Relative compliance effort on observability with consumer standards as in equation (3.3.17) *These graphs are obtained using values* $c_j = 4$, $\partial_{e_{i,j}} S(e_{i,j}) = \partial_{e_{r,j}} R(e_{r,j})$ *and* $a = b$. *The choice of* c_j *does not have any effect on Figure (3.4a), while the effect on Figure (3.4b) is not on the overall trend and limit values, but on the values* ρ *the functions assumes value 1. Specifically, the higher* c_j, *the lower the values of* ρ *at which the function intersects the line 1. It plots the relative level of effort* $\frac{(1-e_{i,j})^b}{(1-e_{r,j})^a}$, *on the y-axes, as a function of* ρ, *on the x-axes. Note that the scale of the y-axes in Figure (3.4a) and (3.4b) are different to improve redeability. The difference in scale is highlighted by the position of the green line* ($y = 1$)

goods because consumers can easily switch between products. When the retailer sells only one product it lacks the ability to leverage the across-product competition to its advantage. Its relative compliance effort, then, is higher than that of suppliers independently of product substitutability (Figure 3.4). Formal proof is in Appendix D.2.

Proposition 3.4.4. *Compliance effort of retailers increases relative to the suppliers' as* $\frac{\partial_{e_{i,j}} S(e_{i,j})}{\partial_{e_{r,j}} R(e_{r,j})}$ *increases;* $\frac{a}{b}$ *increases;* $\frac{N_j}{R}$ *increases.*

Intuitively, as horizontal competition increases, the relatively less competitive segment of the GVC increases its share of compliance effort. When the marginal cost to compliance effort of one firm increases, the other takes on more compliance effort. These results rely on the functional form of $\Gamma(e_{i,j}, e_{r,j})$. Specifically, these functional forms are valid when one firm does not need contribute any effort and it still would be able to benefit from the effort of the other firm.

All the previously outlined results are valid when the double marginalization problem is overcome through the contract outlined in Appendix E. Intuitively, the contract does not substantially alter the relative impact of perceived LES quality.

3.5 Conclusions

The potential of GVCs as vectors to expand labor and environmental protection across national borders (via the intricate and elusive production networks of multinationals) is very attractive. As long as consumers in large export markets expres their preferences for sustainable or fair-labor production processes, GVCs can transmit those standards, silencing the concerns over globalizations' downward pressure on LES.

Critics of this position point out that the expansion of GVCs was accompanied by an increase in global inequality. Traditionally, these critics argue that the globalization of production networks naturally redirects resources towards firms with the most bargaining power (usually the lead firms located in high-income countries), at the expenses of producing firms (usually located in developing countries). Consumer standards exacerbate this unequal profit distribution by tilting the bargaining power within GVCs even more in favor of retailers.

This paper combines the international political economy literature on global transmission of production standards via multinationals; the GVC literature on the determinants of value chain governance and its effects on value captured; and the industrial organization literature on platform retailers. This combination allows to mathematically formalize the governance patterns within multi-product GVCs and investigate the distribution of effort to comply with consumer-driven standards.

The model shows that while public and private regulation can be an effective mechanism to diffuse LES via GVCs, they can exacerbate the natural tendency of GVCs to concentrate rents. When a multi-product retailer sells highly substitutable goods, the high level of price competition among products drives most LES compliance effort and cost on suppliers. For this to be true, however, retailers need to pursue an adequate level of product differentiation. A single-product retailer, instead, is not able to shift those costs completely. It is subject to "across-product" competition as the supplier and lacking that source of bargaining power, effort is equally distributed among suppliers and single-product retailers for highly substitutable products.

We have identical retailers selling multiple products to consumers that love variety and outsourcing production to upstream independent suppliers. This setting outlines three levels of competition: horizontal competition, "across-product" competition, and vertical competition. Their interaction determines the profitability of every firm in the GVC and the bargaining power that shape their relative effort to comply with LES.

The analysis can be extended in multiple ways. First, this is a static model with a fixed GVC structure. Industry standards can change GVC structure and its governance, for instance creating barriers to entry for suppliers.The model shows that even when suppliers are monopolists and retailers are not, the multi-product nature of the retailer drives up suppliers' share of LES compliance effort. Changes in the GVC structure, then, would not change the main result and its implications.

Second, the model assumes that all retailers are identical and does not take into account branding strategies and retailer differentiation attached to LES. In that case, consumers might decide to boycott retailers breaching LES on one product. Differentiation among retailers requires consumers with heterogeneous preferences over LES. This model, then, provides an approximation of the effects of similar retailers competing on a market with given preferences over such attributes. For instance, the competition between Traders' Joes and Wholefoods vs the competition between Wal-Mart and Dollar General.

Finally, we assume that compliance effort only imposes fixed costs to the firms and do not increase their variable costs of operation. Including an increase in the variable cost would not change the final results on the distribution of effort between retailers and suppliers. An increase in the variable costs of operation, in fact, would be transmitted to consumer prices. This introduces a trade off for firms that would drive down their overall level of effort, but not change its distribution.

Additionally, fixed costs of compliance have implications for development and inequality. The high cost of adoption and the high risk resulting from volatile consumer-driven standards limit the diffusion of LES. When consumers frequently upgrade their definition of "quality," the continuous upgrade in production techniques required to satisfy that definition will thwart the ability to recoup the initial investment. This will drive an increasing wedge in profitability between the firm that make the investment and that enjoying the benefit of such investment.

These results create a framework for government intervention. For instance, when an industry is dominated by multi-product multinationals selling highly substitutable products local governments in producing country might subsidize an upgrade in production techniques, as they would unevenly burden suppliers. Conversely, in industries where products are not substitutable, the outsourcing multinational firm has a greater incentive to directly invest in local production, for instance with foreign direct investments. The framework provided outlines cases where local governments in developing countries might want to let the interaction within global markets drive development and redirect resources towards other industries where, for instance, public-private partnerships might be more beneficial.

There is great enthusiasm for consumer-driven standards, certifications and other forms of accountability for outsourcing firms to fulfil the promise of diffusing labor and environmental standards throughout their production networks. Not much attention has been directed to the distribution of LES compliance costs. The model presented shows that the industry structure matters in compliance cost distribution: the interaction between product degree of substitutability and the nature of the downstream outsourcing retailer affect the distribution of compliance effort and hence cost. Consumers and NGOs should be cognisant of these dynamics as they can lead well-meaning LES to increase the vulnerability of producers in the developing world and contribute to global inequality.

Chapter 4

International Transmission of Public and Private Regulation Along Global Value Chains and Its Cost Distribution

Labor and Environmental Standards (LES) can reallocate profits from upstream suppliers to downstream retailers in presence of multi-product retailers. However, some types of environmental regulation shift profits between retailers and suppliers more than others. This paper proposes two forms of labor and environmental regulation. The first one is public regulation imposed by the producing country on the supplier. The second is public regulation imposed by the consuming country on the retailer. Comparing these results to private regulation shows that for all level of product substitutability, retailer compliance effort is the highest when the regulation is imposed on the retailer and the lowest when it is imposed on the supplier. Consumer driven standards are in the middle. These results suggest that compliance cost distribution between suppliers and retailers should be included in the discussion on labor and environmental protection. This is particularly true with environmental benefits that global, when the costs are concentrated on low-income countries.

4.1 Introduction

A 2009 MIT Center for Transportation and Logistics survey showed that the for a group of 300 multinational companies with sales over one billion dollars a year, on average 51% of manufacturing took place outside of the home country (MITCTL, 2009). Most production processes are conducted within Global Value Chains (GVCs) and final sale in developed countries is often facilitated by multi-product retailers that connect producers and consumers. When firms outsource production, they also diffuse the standards that are required to satisfy domestic regulation to protect labor and the environment (Vogel, 1995; Greenhill et al., 2009; Garcia-Johnson, 2000; Perkins and Neumayer, 2012; Prakash and Potoski, 2007, 2006; Poulsen et al., 2016). Labor and Environmental Standards (LES) can reallocate profits from upstream suppliers to downstream retailers in presence of multi-product retailers.

This paper confirms the results on voluntary LES outlined in Chapter 2 for public regulation of two different forms. The first one is public regulation imposed by the producing country on the supplier (imagine the government of Vietnam setting an environmental tax on garment producers, many of whom eventually sell their products to Walmart). The second is public regulation imposed by the consuming country on the retailer (imagine Walmart being taxed if it imports products that harm biodiversity in the producing country). Comparing these results to private regulation of Chapter 2 shows that for all level of product substitutability, retailer compliance effort is the highest when the regulation is imposed on the retailer and the lowest when it is imposed on the supplier. Consumer driven standards are in the middle.

These results are important because the literature on the transmission of LES along GVCs has focused on effectiveness and efficiency as opposed to the fairness of the regulation. However, monitoring companies' supply chains is burdensome and costly. For instance, in 2001 the apparel company Gap estimated that monitoring its entire supply chain for labor abuses would cost up around 40 million dollars a year, roughly 4.5% of the company's annual profits. The distribution of such costs between firms in a GVC can be an important mechanism playing into suppliers' vulnerability. This paper shows that in presence of multi-product retailers, different forms of regulation differentially impact that vulnerability.

LES transmitted across countries can take three forms. Consistent with a national-jurisdiction orientation, the first one stresses the responsibility of producing states. Each country should pass and enforce regulation to avoid abuses of their natural resources and labor. This approach is adopted by the International Labor Organization and various environmental treaties[1]. For instance, the ILO's 1998 *Declaration on Fundamental Principles and Rights at work* maintains the obligation of member countries to uphold the core principles of fair labor, such as the elimination of child and compulsory labor, discrimination and freedom of association. Critics point out that many producing countries lack the regulatory and enforcing capabilities to meet those goals.

A second solution is for the importing country to set production standards. For instance, they can require labor or environmental certifications (Schwartz, 2017; Hussain, 2012). However, these requirements can violate national sovereignty. They allow rich consuming countries with a high degree of bargaining power to interfere in the

[1] International Environmental Agreements Database Project, University of Oregon

governance of poorer states. They can also violate WTO rules on technical barriers to trade.

A third option is private regulation set by consumers and enforced by their purchasing choices, what is called *conscious consumption* or *political consumerism* (Willis and Schor, 2012). Consumers have been able to fill a regulatory vacuum by influencing firms' behavior. In the 1990s, Nike faced a scandal over poor working conditions in factories run by independent suppliers. Under pressure from its stakeholders the company had to change its supply chain management (Niesen, 2013). In the 1970s, Nestle was under fire for its promotion of infant formula over breastfeeding that led to health issues in poorer countries. After consumers reacted, the company developed an industry code of conduct whose provisions where internalized by many countries' legislations (Nelson-Horchler, 1984).

This approach was embraced by many NGOs that aim at informing and directing consumer choices[2]. The UN Sustainable Development Goals (*UNSDG 12: Ensure sustainable consumption and production patterns*) recognizes the need for a "systemic approach and cooperation among actors operating in the supply chain, from producer to final consumer." It pinpoints sustainable consumption as pivotal to ensure sustainable production processes. The relevance of elusive information on industry practices within hard-to-monitor value chains and the potential for "green washing" or "fair washing" weakens the strength and scope of conscious consumption.

[2]For instance, the Slave Free Chocolate Coalition directs consumers to chocolate brands certified as free from unethical labor practices, such as child labor, traficking and slavery, that still taint the cocoa industry. The *Conflict-Free Campus Initiative (CFCI)* within the Enough Project encourages college students to voice their "demand for conflict-free products from Congo" influencing universities, who are large buyers of electronics, to "pressure electronics companies to responsibly invest in the Democratic Republic of Congo's minerals sector." *Ethical Consumer* provides a guide of products and brands whose production process respect some environmental, ethical and labor standards and a similar guide -the Good Shopping Guide- is provided by *UK's Ethical Company Organization*. The *Say No To Palm Oil* project direct consumers to brands for consumer products that are palm oil-free, thus not considered to further endanger the orangoutangs and their ecosystem

This paper contributes to three streams of literature. It complements the literature on the transmission of environmental regulation via multinational entreprises and consumer-driven standards with the issue of cost distribution of such regulation (Garcia-Johnson, 2000; Perkins and Neumayer, 2012; Prakash and Potoski, 2007, 2006; Greenhill et al., 2009). It contributes to the industrial organization literature on platforms concerning the transmission of the tax and the cost of tax avoidance with a focus on LES (Nakamura, 2008; Nakamura and Zerom, 2010; Gopinath and Itskhoki, 2010; Gopinath et al., 2010, 2011; Goldberg and Hellerstein, 2008; Burstein and Jaimovich, 2009; Atkeson and Burstein, 2008; Auer and Schoenle, 2016; Amiti et al., 2014; Neiman, 2010, 2011; Hellerstein and Villas-Boas, 2010; Iapadre and Pace, 2016; Boudreau and Hagiu, 2009). It supports the GVC literature by complementing its traditional focus of regulation as a barrier to entry, highlighting a channel through which LES can impact the vulnerability of producers, independently of their effects on value chain structure, that the GVC empirical literature has exposed (Dolan and Humphrey, 2000; Kaplan and Kaplinsky, 1999; Ponte and Gibbon, 2005; Neilson, 2008; Cafaggi and Renda, 2012).

I present a theoretical model based on Chapter 2 where suppliers produce a good that is sold to multi-product retailers and resold to the consumers. Consumers love variety and divide their fixed income over all goods in proportion to their relative price and their degree of substitutability. Final prices are driven by the level of competition at the supplier and the retailer level, as well as the substitutability among goods and are influenced by a tax over an environmental externality. The tax regime, that takes the form of a tax on the retailer (section 4.2.4) or a tax on the supplier (section 4.2.5) has different impacts on suppliers' and retailers' relative profits, driving differential in compliance effort, as presented in Section 4.3.

Results confirm the private regulation outcomes of Chapter 2. When a multi-product retailer sells complementary products, it will absorb most of the cost from switching to a sustainable production process. As products become more and more substitutable, the multi-product retailer (not a single-product retailer) is able to shift those costs on the suppliers. A comparison between private and public regulation shows that consumer-driven standards prompt a higher level of relative compliance effort for the suppliers compared to the case when formal regulation is imposed on the retailer. For a single-product retailer, though, there is no difference between downstream regulation of the private and public kind. Intuitively, a multi-product retailer is more effective at using product substitutability to its advantage to shift compliance costs on suppliers. Suppliers bear most of the cost of upgrading production when the local regulator imposes a tax directly on the suppliers.

This process raises questions over the pass-though of the cost to meet standards of production and the ability of suppliers to bargain over profitable market conditions. When product and production standards are common and production processes are vertically disintegrated, it is important to assess who bears the cost of socially beneficial interventions that aim at protecting labor and the environment. This is particularly true when the benefits of the regulation are global, for instance mitigating global warming, but the costs are concentrated in producing countries. Policies can be designed to mitigate these issues on distribution and economic development, but also to better target environmental intervention by understanding what sides of the market are more likely to support or reject them.

The comparison between public and private regulation explains why costly and voluntary LES can be imposed even in the absence of a price premium for sustainable products. Both suppliers and retailers, in fact, strictly prefer private regulation to public regulation imposed by the home country regulator. The model suggests that introducing voluntary standard serves the purpose of delaying a burdensome public regulation.

There are also implications for the political economy of environmental and labor regulation. Producing countries, in fact, have an incentive to delay regulating their economies when downstream stages of the value chain are subject to standards either by public or private regulation. On the other side, a regulator in the consuming country that is not concerned with inequality might also hold off on imposing formal regulation on domestic firms, and pressure producing countries to regulate their own economies. Private regulation would also deter the same regulator in a consuming country from imposing formal standards on domestic firms. Consumers and NGOs that want to influence the sourcing strategies of the firms they purchase from should opt for pressuring their own regulator to impose public standards on downstream multinationals as it places the least financial burden on upstream suppliers especially for substitutable products.

Despite the abundance of case studies and their richness there is not much formal theoretical work on these questions, limiting external validity. A similar analysis was conducted in Chapter 1, where a ranking between different trade-based development policies was provided based on the distribution of benefits along a GVC. The modelling strategy is different, though: a linear value chain with a flexible number of stages and competitors per stage to evaluate changes in relative distribution stemming from economic development policies as a function of firms stage of production. The results of this paper are compared to a linear value chain by comparing a multi-product and single-product retailer scenarios.

In conclusion, this model provides the opportunity to answer the question of how regulation and consumer standards protecting labor or the environment affect bargaining power and hence surplus distribution among firms involved in value chains. In a context where downstream multi-product retailers sell a variety of partially substitutable products sourced by upstream independent suppliers, who pays the cost of the technical upgrading necessary to abide to LES? Under what condition does public or private regulation increase global inequality? Which type of regulation has the most impact on inequality?

4.2 A Model of Public Regulation Along GVCs

4.2.1 Intuition

The model presented in this section is similar to that of Chapter 2, with the difference that consumers do not know or care about LES. The regulator needs to intervene with formal standards in order for LES to be complied with.

A set of consumers enjoys a variety of products they can purchase at a given retailer. Their limited budget forces them to make trade offs among goods according to their prices and the elasticity of their demand. Retailers are undifferentiated: they all offer the same products for the same prices. They outsource production to independent suppliers. Each good is produced by at least one supplier, but not necessarily only one.

The final profits of suppliers are subject to three competitive pressure: horizontal competition, driven by the multiple suppliers of a single product variety; ”across-product” competition, induced by product varieties competing over the limited budget of the final consumers; and vertical competition, determined by the division of rents from the final sale of the product among retailers and suppliers. The final profits of retailers, instead, are only subject to horizontal and vertical competition as the ”across-products” competition is nullified by the sale of all product varieties. This is because, when the price of one product increases, demand for every other product goes up.

Profits are determined by the quantity sold of each product and the mark-ups suppliers and retailers impose when optimally setting their wholesale and final prices. Prices are going to be determined by the level of competition at the retailer stage, the level of competition at the supplier stage and the degree of substitutability among products. Mark-ups are lower the more substitutable products are, as in a monopolistic competition setting, because the final demand for substitutable products is elastic. Mark-ups decrease with the number of horizontal competitors, as expected.

Given this setting, imagine that one of the goods is taxed because it violates LES. Taxation is explored at both the manufacturing and retailing stage. Specifically, the regulator in the consuming country can impose a tax on domestic retailers if they import goods that do not meet the required LES. An example of this type of regulation is the Lacey Act that limits US imports of goods harmful to biodiversity in producing countries. This is the "Tax on the Retailer" case of Section 4.2.4. In the "Tax on the Supplier" case of Section 4.2.5, the producing country introduces a Pigouvian tax on domestic producing firms over a negative externality.

In both cases, the burden of the tax affects suppliers through its effect on final prices (increased) and hence quantity consumed (decreased). The retailers' profits are also affected by the tax. Profits on the taxed product drop like those of suppliers. Nevertheless, this effect is mitigated by the increase in profits on every other product. As the relative price of one good increases, in fact, consumers switch to its closest substitutes sold by the same retailer, a shift that is larger for highly substitutable products. A decrease in the consumption of the taxed good translates in an increase in consumption of the untaxed products sold by the same retailer.

Compliance with LES avoids the tax. Suppliers can invest in a new production technology and retailers can contribute to that investment. This section will investigate the contribution compliance cost by suppliers and retailers. Results show that, when products are not substitutable, suppliers have a high bargaining power because retailers want to sell the entire basket of products. They will thus be able to shift upgrading costs on to the retailer. This is not true when products are highly substitutable. In that case, as suppliers are subject to relatively more competitive pressure (the "across-goods" component) decreasing their bargaining power. Multi-product retailers can then shift the cost of compliance with LES on to suppliers. However, this only happens with a diversified product offering by the retailer: a single product retailer would not be able to shift those costs, very much as in Chapter 2.

The same logic applies to the case where suppliers and retailers can design a contract to overcome the double marginalization problem: final prices are higher and aggregate prices are lower than they would be with a vertically integrated firms. When the number of suppliers is greater or equal than the number of retailers, retailers can offer part of the profits from the sale of the good at the vertically integrated price in exchange for the truthful revelation of marginal cost of production and a fixed entry cost to consumers and suppliers. In this setting, as in the previous one, upgrading efforts would still be overwhelmingly born by suppliers for highly substitutable products, as long as the retailer sells multiple goods. Similar results apply when the tax is imposed on suppliers, as described in Section 4.2.5.

4.2.2 Baseline Model

The baseline model is similar to the model in Chapter 2, with the only difference that consumers do not know or care about LES. This translates into $\gamma = 0$, which is going to be set throughout the model.

Imagine a Global Value Chain with two stages, as the one described in Figure

2.1. Manufacturers are upstream and produce J goods indexed with $j \in [1, J]$. These goods are partially substitutable. The variable $\rho \in (0, 1)$ determines their degree of substitutability: the higher ρ the more substitutable goods are.

A variable number of identical suppliers, $i = [1, N_j]$ $N_j \in [1, \infty)$, produces each good j. The total quantity of j on the market, q_j, is the sum of $q_{i,j}$: the quantity produced by supplier i of good j. Suppliers sell their products to retailers. There is a variable number of identical retailers $R \in [1, \infty)$, indexed with $r \in [1, R]$, competing to buy the product from the suppliers and sell them to the final consumer. There is no specialisation in retailing services: all retailers sell all varieties produced.

4.2.2.1 The Consumer Problem

The representative consumer has income Y that is distributed over the entire set of products. It maximizes a utility function over quantities of the form $U = \sum_{k=1}^{J} q_k^{\rho}$, given the budget constraint $Y = \sum_{k=1}^{J} p_k q_k$. They enjoy consuming every good, but their fixed income forces them to trade them off considering their degree of substitutability and their prices.

Consumer optimization problem (4.2.1) yields a demand for each good, represented in equation (4.2.2) that is increasing in income and the price of every other good (represented by the price index G in equation (4.2.3)). It is also decreasing in its own price in a way that depends on the degree of substitutability between goods. Demand is more elastic when goods are substitutable [3].

[3] Usually these types demand systems substitute ρ, goods' substitutability, with $\sigma = \frac{\rho}{\rho-1}$ the elasticity of demand. The resulting demand would then be expressed as $q_j = \frac{Y}{G} p_j^{1-\sigma}$ with $G = \sum_{j=1}^{J} p_j^{\sigma}$. However, in order to preserve the intuition of the effect of goods substitutability on the outcomes of interest, I am going to keep all functions expressed in terms of ρ.

$$\begin{aligned} \underset{q_j}{\text{maximize}} \quad & U = \sum_{k=1}^{J} q_k^{\rho} \\ \text{subject to} \quad & Y = \sum_{k=1}^{J} p_k q_k \end{aligned} \tag{4.2.1}$$

$$q_j = \frac{Y}{G} p_j^{\frac{1}{\rho-1}} \tag{4.2.2}$$

$$G = \sum_{j=1}^{J} p_j^{\frac{\rho}{\rho-1}} \tag{4.2.3}$$

4.2.3 The Retailer and The Supplier Problem

Retailers and suppliers observe this demand function and maximize their profits in the same fashion as optimization problems (3.3.6) and (3.3.8), yielding the same optimal retail prices and wholesale prices as equation (3.3.7) and (3.3.9). Final consumer prices are the same as equation (3.3.10).

Equilibrium profits for retailers and suppliers are:

$$\pi_r^* = \sum_{k=1}^{J} (\beta_r - 1)\beta_k c_K (\frac{Y}{G} (\beta_r \beta_k c_k)^{\frac{1}{\rho-1}}) \tag{4.2.4}$$

$$\pi_{i,j}^* = (\beta_j - 1)c_j (\frac{Y}{G} (\beta_r \beta_j c_j)^{\frac{1}{\rho-1}}) \tag{4.2.5}$$

4.2.4 Tax on the Retailer

The production of good j is taxed for violating LES. Assume production and retail take place in different countries and goods move across locations without transportation costs[4]. It is most natural that taxation on a negative externality takes place in the producing country. However, if production takes place in an under-regulated economy, the consuming country might want to complement regulation by imposing a tax, $t_j \in [0, 1]$, on imports that do not comply with LES[5].

This section considers the case where the the tax is imposed in the consuming country on domestic retailers. The case where the tax is imposed by producing countries on domestic suppliers is discussed in Section 4.2.5. Results for both are discussed in Section 4.3.

When the tax is imposed on retailers in the consuming country, retailers are maximising a profit function that include the tax $\pi_r = \sum_{k \in [1,J]/j} p_k q_{r,k} - g_k q_{r,k} + p_j(1-t_j)q_{r,j} - g_j q_{r,j} - F$. The solution to that maximisation process given the consumer demand in equation (3.3.5), is shown in equation (4.2.6), where TR stands for 'Tax on Retailer.'

$$p_j^{TR}(t_j) = \beta_r \frac{g_j}{1-t_j} \tag{4.2.6}$$

Knowing the retailers optimal pricing strategy and its impact on final demand, supplier i of good j needs to maximise profits of the form $\pi_{i,j} = (g_j - c_j)q_{i,j}(p_j^{TR}(t_j))$ that yields optimal wholesale prices of the form of equation (3.3.9)[6]. Substituting equation (3.3.9) into equation (4.2.6) yields optimal consumer price.

[4]Transportation costs can easily be added to the model, but they do not alter the variable of interest: the relative upgrading effort of retailer and suppliers.

[5]The underlying assumption is that the regulator in consuming and producing countries are equally capable of detecting the externality, eliminating the opportunity for retailers to offshore production to hide their environmental impact. This assumption is naive, but it simplifies our analysis. However, to include monitoring capabilities, a simple expected value of the tax can be substituted to the tax rate, where the tax t_j is weighted by the probability of detection. It would simply decrease the extent of the tax.

[6]Final price in equilibrium when the tax is on the retailer $(p_j(t_j)^{TR})$ is equal to the final price when the tax is on the supplier p_j^{TS} as in Section 4.2.5, which means that consumer demand is the same under the two regimes for a given level of t_j

The equilibrium profits of the retailer and the supplier take the form of equation (4.2.7) and (4.2.9) respectively, where $q_j^{TR}(t_j) = q_j(p_j^{TR}(t_j))$

$$\pi_r^{TR} = \frac{1}{R}(\sum_{k\in[1,J]/j}(p_k - g_k)q_k + (p_j^{TR}(1-t_j) - g_j)q_j^{TR}(t_j)) \tag{4.2.7}$$

$$= \frac{1}{R}(\sum_{k\in[1,J]/j}(p_k - g_k)q_k + (\beta_r - 1)\beta_j c_j q_j^{TR}(t_j)) \tag{4.2.8}$$

$$\pi_{i,j}^{TR} = \frac{1}{N_j}(g_j - c_j)q_j^{TR}(t_j) = \frac{1}{N_j}(\beta_j - 1)c_j q_j^{TR}(t_j) \tag{4.2.9}$$

The derivative with respect to t_j of the two equilibrium profits delivers the impact of the tax on suppliers' and retailers' profits. The effect of the tax on the profits of the retailer is composed of two parts: the first part is the negative effect on the sales of good j, given by its after-tax price increase and the increase in its wholesale price. The second part is a positive effect given by the increase in sales of all other goods. Since the price of good j relative to every other good available is higher than before the tax, part of tits final demand will shift to all other goods. Product substitutability intensifies this shift. This second positive component mitigates the negative effect of the first part. Suppliers' profits, instead, drop like the first part of the retailers' profit without the positive effect on other goods.

These results require the assumption that the price index G is fixed for the supplier, but not for the retailer. The underlying assumption is that even when the supplier of good j is a monopolist, it still remains a small actor in the market because there is a large number of goods sold. The effect of an increase in price j on good j, then, has only a negative effect. At the same time G is assumed not to be fixed for the retailers. They are able to benefit from shift in consumption from taxed to untaxed goods and even if this shift has a minimal effect on the quantity consumed of every single good. Appendix G elaborates on these statements and provides formal proof.

$$\frac{\partial \pi_{i,j}^{TR}}{\partial t_j} = (\beta_j - 1)c_j \frac{1}{N_j} \frac{\partial q_j^{TR}(t_j)}{\partial t_j} = (\beta_j - 1)c_j \frac{1}{N_j} q_j^{TR}(t_j) \frac{1}{1-t_j} \frac{1}{\rho - 1} \tag{4.2.10}$$

$$\frac{\partial \pi_r^{TR}}{\partial t_j} = \underbrace{\frac{Y}{G}(\frac{\beta_r \beta_j c_j}{1-t_j})^{\frac{1}{\rho-1}} \frac{\beta_j c_j}{\rho - 1} \frac{(\beta_r - 1)}{1-t_j}}_{\text{negative effect}} - \underbrace{\frac{\rho}{\rho - 1} \frac{1}{1-t_j} (\frac{\beta_r \beta_j c_j}{1-t_j})^{\frac{\rho}{\rho-1}} \frac{1}{G} \sum_{k=1}^{J} (p_k - g_k) q_k(t_j)}_{\text{positive effect}} \tag{4.2.11}$$

4.2.4.1 Adding Compliance Effort

Firms can take a costly action to comply with regulation and decrease the magnitude of the tax. For instance, they can upgrade production process or purchase certification[7]. The tax is a function of the levels of effort of supplier ($e_{i,j} \in [0,1]$) and retailer ($e_{r,j} \in [0,1]$) is expressed by equation (4.2.12) and is shown in Figure 4.1.

$$t_j(e_{i,j}, e_{r,j}) = t[(1 - e_{i,j})^a + (1 - e_{r,j})^b] \tag{4.2.12}$$

Function (4.2.12) assumes that efforts are bounded between 0 and 1 and $a, b \geq 1$. Efforts are not complementary, the tax would decrease even if one of the actors decides to free ride on the effort of the other. Both suppliers and retailers benefit from a production upgrade that drives down the impact of the tax, but both would

[7]Similarly, they can take an action to hide the externality and decrease probability of detection.

prefer the other to incur in its costs. If we are considering the effect of the retailer's effort, the greater the level of effort (the closer to one), the lower the bite of the tax. If the effort of the supplier increases, then the curve shifts down: the magnitude of the tax is smaller. When the level of supplier's effort decreases, the curve shifts up for any effort of the retailer: the magnitude of the tax is larger[8].

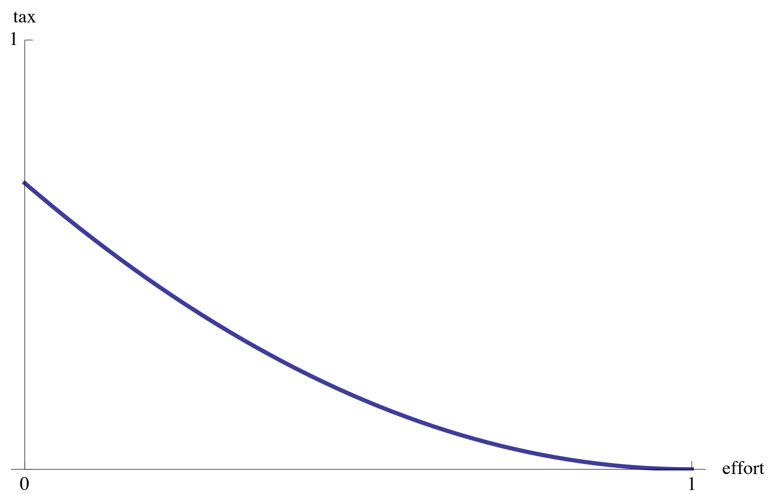


Figure 4.1*:* Tax Function (4.2.12): *This figure graphs equation (4.2.12) for values:* $a = b = 2$, $t = \frac{2}{3}$ *and other effort equal to one.*

Retailer and suppliers incur in different fixed costs for their compliance effort, $R(e_{r,j})$ and $S(e_{i,j})$ respectively. Costs are increasing in own effort[9].

[8]Results are robust for multiple choices of tax forms as long as efforts are substitutable. When efforts are complementary, i.e. both retailers and suppliers need to exert some effort in order to limit the impact of the tax, results on relative efforts are reversed, suggesting a stronger role for retailers' bargaining power. However, while complementary efforts seem applicable in the case of consumer-driven standards, for instance when producers engage in sustainable production processes, but their effort is only compensated by consumers if retailers advertize those characteristics, it does not seem as applicable in the case of public regulation.

[9]Including an increase in the variable cost would not drastically change the final results on the distribution of effort between retailers and suppliers. An increase in the variable costs of operation is transmitted to the consumer prices. The resulting increase in effort would decrease the effect of the tax on price, but at the same time increase the variable cost of production. This introduces a trade off for firms that would drive down their overall level of effort, but not change its distribution. Additionally, fixed costs of upgrading the production process have implications for development and inequality. For instance, the high cost of adoption and the high risk resulting from volatile consumer-driven standards hamper the diffusion of environmental certification.

Suppliers and retailers face the problem of picking their optimal effort, given the effort of the other one. In the presence of the tax, the profits for retailer r and supplier i of good j are $\pi_r(e_{i,j}, e_{r,j})^{TR} = \pi_r^{TR} - R(e_{r,j})$ and $\pi_{i,j}(e_{i,j}, e_{r,j})^{TR} = \pi_{i,j}^{TR} - S(e_{i,j})$, where π_r^{TR} and $\pi_{i,j}^{TR}$ are as in equation (4.2.7) and (4.2.9) respectively.

Optimal compliance effort is obtained by maximizing these profit functions with respect of own effort. The result of equation (4.2.13) follows from taking the ratio of the efforts and represents the relative level of effort of retailers and suppliers. Appendix G shows the derivation of these results. Equation (4.2.13) is composed of two parts. The first component (A) determines the level of effort as driven by the impact in profits on the taxed product line, while the second (B) is driven by the change in profits on every good other than the taxed one. Therefore, if the retailer only sells product j, the second part of the equation would be equal to zero. These two effects are weighted by the relative marginal cost of the compliance effort and the relative level of competition.

$$\frac{(1-e_{i,j})^{b-1}}{(1-e_{r,j})^{a-1}}\Big|_{TR} = \frac{a}{b}\frac{\partial_{e_{i,j}} S(e_{i,j})}{\partial_{e_{r,j}} R(e_{r,j})}\frac{N_j}{R}\Big(\underbrace{\frac{(\beta_r-1)\beta_j}{\beta_j-1}}_{A} - \underbrace{\frac{\rho}{(\beta_j-1)c_j}(\frac{\beta_r\beta_j c_j}{1-t_j})^{\rho}(1-\frac{1}{\beta_r})}_{B}\Big) \tag{4.2.13}$$

4.2.5 Tax on the Supplier

When the tax is imposed by the producing country on domestic producers of j, retailers' problem remains as in equation (3.3.6). Optimal retail pricing strategy, then, will be the same as in equation (3.3.7). The problem of supplier i of good j, instead, changes as her profits become $\pi_{i,j} = (g_j(1-t_j) - c_j)q_{i,j}$ given the demand function (3.3.8). Profit maximisation given the optimal pricing strategy of the retailer yields optimal wholesale prices (4.2.14). Optimal consumer price p_j^{TS} is obtained by substituting equation (4.2.14) into (3.3.7) where TS stands for 'Tax on Supplier.'

$$g_j^{TS} = \beta_j \frac{c_j}{1-t_j} \tag{4.2.14}$$

Equilibrium profits of the retailer and the supplier take the form of equation (4.2.15) and (4.2.17) respectively, where $q_{r,j}^{TS} = q_{r,j}(p_j^{TS})$

$$\begin{aligned} \pi_r^{TS} &= \frac{1}{R}\Big(\sum_{k\in[1,J]/j}(p_k - g_k)q_k + (p_j^{TS} - g_j^{TS})q_j^{TS}\Big) & (4.2.15)\\ &= \frac{1}{R}\Big(\sum_{k\in[1,J]/j}(p_k - g_k)q_{r,k} + (\beta_r - 1)\beta_j \frac{c_j}{1-t_j} q_{r,j}^{TS}\Big) & (4.2.16)\end{aligned}$$

$$\pi_{i,j}^{TS} = \frac{1}{N_j}((1-t_j)g_j^{TS} - c_j)q_j^{TS} = \frac{1}{N_j}(\beta_j - 1)c_j q_j^{TS} \tag{4.2.17}$$

The tax has a negative effect on good j profits for both the supplier and the retailer. A positive effect on the sale of every other product mitigates it for the retailer, but not for the supplier. For a single-product retailer of j, the second part of equation (4.2.19) would be null.

$$\frac{\partial \pi_{i,j}^{TS}}{\partial t_j} = (\beta_j - 1)c_j \frac{1}{N_i}\frac{\partial q_j^{TS}}{\partial t_j} = (\beta_j - 1)c_j \frac{1}{N_i} q_j^{TS} \frac{1}{1-t_j}\frac{1}{\rho - 1} \tag{4.2.18}$$

$$\frac{\partial \pi_r^{TS}}{\partial t_j} = \underbrace{\frac{1}{R}\Big(\frac{(\beta_r - 1)\beta_j c_j}{(1-t_j)^2} q_j^{TS} \frac{\rho}{\rho - 1}}_{\text{negative effect}} \underbrace{- \frac{\rho}{\rho-1}\frac{1}{1-t_j}\Big(\frac{\beta_r\beta_j c_j}{1-t_j}\Big)^{\frac{\rho}{\rho-1}} \frac{\sum_{k=1}^{J}(p_k - g_k)q_k(t_j)}{G}}_{\text{positive effect}} \tag{4.2.19}$$

4.2.5.1 Adding Compliance Effort

When adding a functional for as in equation (4.2.12) for $t_j(e_{i,j}, e_{r,j})$ that depends on efforts, the function of relative effort (4.2.20) can be obtained as specified by Section 4.2.4.1 and Appendix G. The second part (B) of equation (4.2.20) is identical to (B) in equation (4.2.13), while the first part (A) is different.

$$\frac{(1-e_{i,j})^{b-1}}{(1-e_{r,j})^{a-1}}\Big|_{TS} = \frac{a}{b}\frac{\partial_{e_{i,j}} S(e_{i,j})}{\partial_{e_{r,j}} R(e_{r,j})}\frac{N_j}{R}\Big(\underbrace{\frac{(\beta_r-1)\beta_j\rho}{\beta_j-1}}_{A} - \underbrace{\frac{\rho}{(\beta_j-1)c_j}(\frac{\beta_r\beta_j c_j}{1-t_j})^{\rho}(1-\frac{1}{\beta_r})}_{B}\Big) \tag{4.2.20}$$

4.3 Results

The main result of this model is that the relative compliance effort of a multi-product retailer is going to be higher with consumer driven standards compared to the case of public regulation imposed on the retailer. The relative compliance effort of the retailer is going to be the lowest when the public regulation is imposed on the supplier. This is true for every level of product substitutability, keeping horizontal competition constant. This ranking allows to prioritise policies that equally protect labor and the environment on the bases of a fair compliance cost distribution. What follows is a formal description of the these results and their derivation.

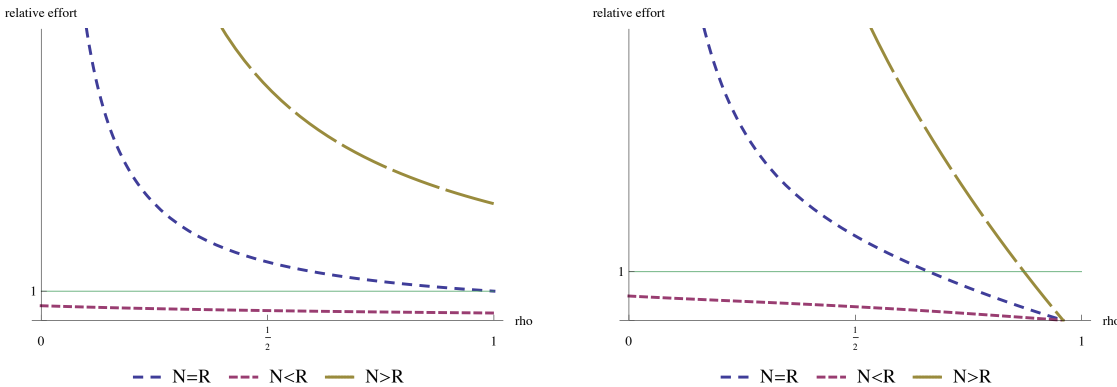
The basic results of Chapter 2 remain valid: as product substitutability increases, a multi-product retailer is increasingly able to shift LES compliance costs on to its suppliers (Figure 4.2b). A single-product retailer is not able to completely shift those costs because it cannot leverage product substitutability as effectively to increase its bargaining power with respect to suppliers. As the cost of the marginal unit of effort to the retailer goes down or the marginal effectiveness of its effort goes up, compliance effort of the retailer is more cost effective. Taking everything else equal the retailer will bestow relatively more compliance effort. The same valid if the advantage were to be to supplier. When the level of horizontal competition increases at the supplier level, their profits decrease and with it the incentive to invest in LES compliance. For the same reason, when the horizontal competition at the retailer level increases, the relative effort of the suppliers goes up.

Similar trends are at play when public regulation is imposed on the supplier, as shown in Figure 4.3b. The difference is that, for a single-product retailer, the relative effort of the retailer with respect to the supplier never goes to one as the products become more and more substitutable. Additionally, the effort of the multi-product retailer does not approach one as products approach perfect complementarity. Intuitively, suppliers are unable to shift compliance cost on to the retailer as effectively as retailers can.

Proposition 4.3.1. *Relative compliance effort* $\frac{(1-e_{i,j})^b}{(1-e_{r,j})^a}$ *is greater when the tax is imposed on the multi-product retailer than with consumer driven standards, which in turn is greater than relative compliance effort when the tax is imposed on the supplier for a given* ρ *and for equal levels of horizontal competition:* $\left.\frac{(1-e_{i,j})^b}{(1-e_{r,j})^a}\right|_{TR} \geq \left.\frac{(1-e_{i,j})^b}{(1-e_{r,j})^a}\right|_{CS} \geq \left.\frac{(1-e_{i,j})^b}{(1-e_{r,j})^a}\right|_{TS} \forall \rho \in (0,1)\, \forall N_j = R.$

Proposition 4.3.2. *Relative compliance effort* $\frac{(1-e_{i,j})^b}{(1-e_{r,j})^a}$ *is identical when the tax is imposed on the single-product retailer compared to consumer driven standards. It is greater than relative compliance effort when the tax is imposed on the supplier for a given* ρ *and for equal levels of horizontal competition:* $\left.\frac{(1-e_{i,j})^b}{(1-e_{r,j})^a}\right|_{TR} = \left.\frac{(1-e_{i,j})^b}{(1-e_{r,j})^a}\right|_{CS} \geq \left.\frac{(1-e_{i,j})^b}{(1-e_{r,j})^a}\right|_{TS} \forall \rho \in (0,1)\, \forall N_j = R.$

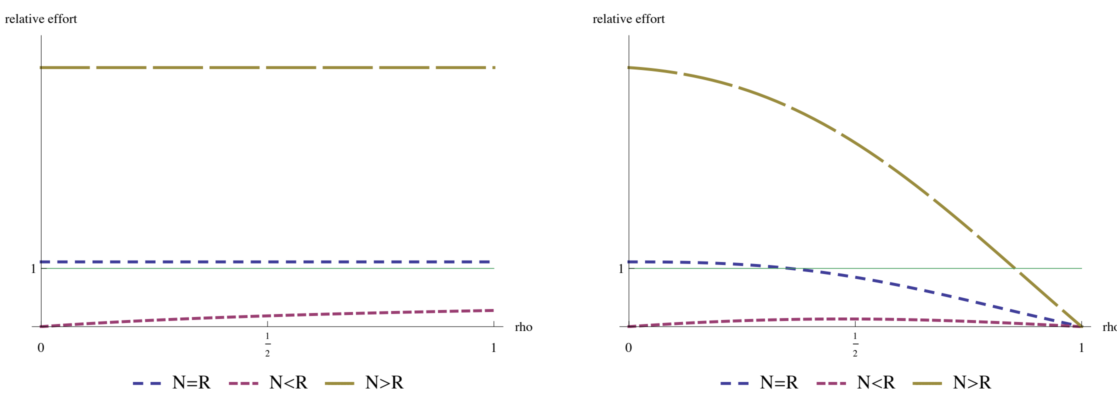
Proposition 4.3.1 and Figure 4.4 show that the relative compliance effort of the



(a) Single product retailer

(b) Multi-product retailer

Figure 4.2*:* Relative compliance effort when the retailers are taxed on good j as in equation (4.2.13): *These figures represent equation (4.2.13) using values* $t_j = 0.1$ *and* $c_j = 4$, $\partial_{e_{i,j}} S(e_{i,j}) = \partial_{e_{r,j}} R(e_{r,j})$ *and* $a = b$. *The choice of* t_j *and* c_j *does not have any effect on Figure 4.2a, while the effect on Figure 4.2b is not on the overall trend and limit values, but on the values* ρ *the functions assumes value 1. Specifically, the higher* c_j *and* t_j*, the lower the values of* ρ *at which the function intersects the line 1. It plots the relative level of effort* $\frac{(1-e_{i,j})^b}{(1-e_{r,j})^a}$*, on the y-axes, as a function of* ρ*, on the x-axes. Note that the scale of the y-axes in Figure (4.2a) and (4.2b) are different to improve redeability. The difference in scale is highlighted by the position of the green line (*$y = 1$*)*



(a) Single product retailer

(b) Multi-product retailer

Figure 4.3*:* Relative compliance effort when the suppliers are taxed on good j as in equation (4.2.20): *These figures represent equation (4.2.20) using values* $t_j = 0.1$ *and* $c_j = 4$, $\partial_{e_{i,j}} S(e_{i,j}) = \partial_{e_{r,j}} R(e_{r,j})$ *and* $a = b$. *The choice of* t_j *and* c_j *does not have any effect on Figure (4.3a), while the effect on Figure (4.3b) is not on the overall trend and limit values, but on the values* ρ *the functions assumes value 1. Specifically, the higher* c_j *and* t_j*, the lower the values of* ρ *at which the function intersects the line* $y = 1$*. It plots the relative level of effort* $\frac{(1-e_{i,j})^b}{(1-e_{r,j})^a}$*, on the y-axes, as a function of* ρ*, on the x-axes.*

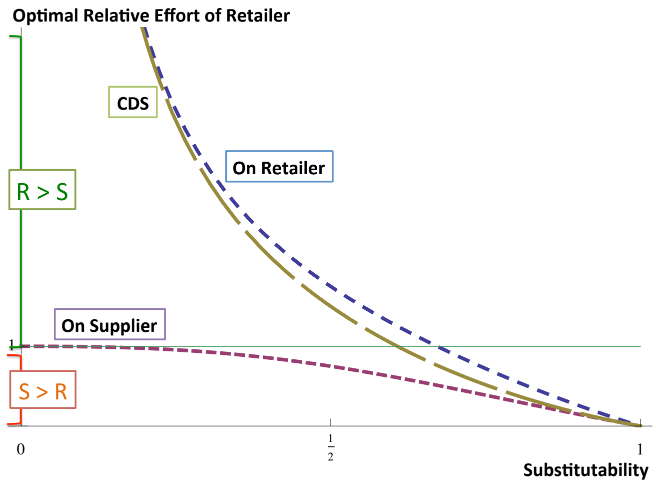


Figure 4.4*:* Comparing Optimal Relative Effort in Private and Public Regulation with a Multi-Product Retailer *These figures are obtained by using values $c_j = 4$, $\partial_{e_{i,j}} S(e_{i,j}) = \partial_{e_{r,j}} R(e_{r,j})$ and $a = b$. The choice of c_j does not have any effect on Figure (3.4a), while the effect on Figure (3.4b) is not on the overall trend and limit values, but on the values ρ the functions assumes value 1. Specifically, the higher c_j, the lower the values of ρ at which the function intersects the line 1. It plots the relative level of effort $\frac{(1-e_{i,j})^b}{(1-e_{r,j})^a}$, on the y-axes, as a function of ρ, on the x-axes.*

retailer compared to the supplier is the lowest when producing countries regulate domestic suppliers. Intuitively, suppliers cannot shift the impact of a tax on retailers as effectively. They bargaining power is lower than the multi-product retailers' bargaining power because suppliers are subject to relatively more competitive pressure (the "across-product" competition component).

Proposition 4.3.1 also shows that the relative effort of the retailers is higher with public regulation in the consuming country compared to consumer-driven standards (in Figure 4.4) the function for the CDS case is below that of TR for every value of ρ). This follows from the fact that the bite of a tax is independent of product substitutability. Differently, the ability of consumers to boycott products on the base of LES compliance depends on the availability of close substitutes. That makes LES compliance effort of retailers stemming from consumer-driven standards more elastic

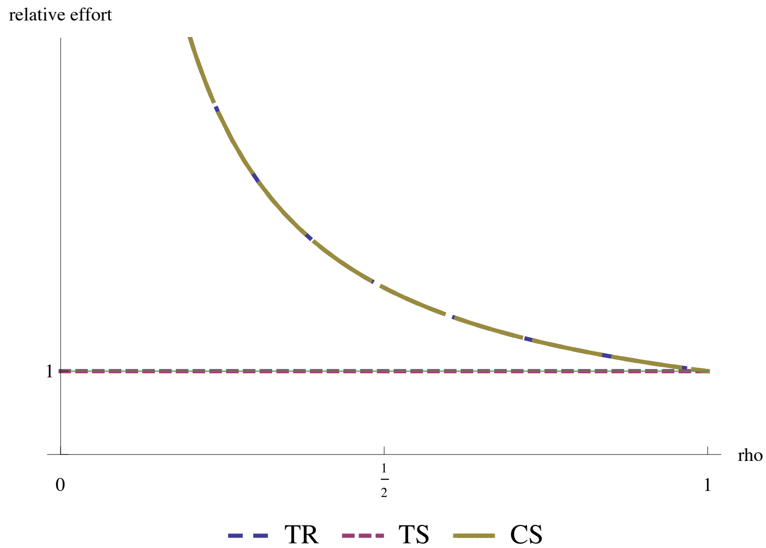


Figure 4.5*:* Comparing Optimal Relative Effort in Private and Public Regulation with a Single-Product Retailer*These figures are obtained by using values $c_j = 4$, $\partial_{e_{i,j}} S(e_{i,j}) = \partial_{e_{r,j}} R(e_{r,j})$ and $a = b$. The choice of c_j does not have any effect on Figure (3.4a), while the effect on Figure (3.4b) is not on the overall trend and limit values, but on the values ρ the functions assumes value 1. Specifically, the higher c_j, the lower the values of ρ at which the function intersects the line 1. It plots the relative level of effort $\frac{(1-e_{i,j})^b}{(1-e_{r,j})^a}$, on the y-axes, as a function of ρ, on the x-axes.*

to product substitutability compared to the tax on retailers case.

In order to use product substitutability to their advantage, retailers need to be less impacted by the "across-product" competition component compared to their suppliers. A single-product retailer, then, would not be able to shift more compliance costs on to their suppliers in the with consumer driven standards compared to a tax on the retailer, as shown in Proposition 4.3.2 and Figure 4.5.

4.4 Conclusions

The literature on labor and environmental regulation in GVCs focuses on the international transmission of such regulation (Vogel, 1995; Greenhill et al., 2009; Garcia-Johnson, 2000; Perkins and Neumayer, 2012; Prakash and Potoski, 2007, 2006; Poulsen et al., 2016) and its efficacy (Schwartz, 2017; Hussain, 2012; Hochschild, 2006). While there is empirical evidence that LES can have distributional effects between suppliers and retailers (Dolan and Humphrey, 2000; Kaplan and Kaplinsky, 1999; Ponte and Gibbon, 2005; Neilson, 2008; Cafaggi and Renda, 2012), the reason why this is true has not been framed theoretically with the same attention given to pass-through of tariffs (Nakamura, 2008; Nakamura and Zerom, 2010; Gopinath and Itskhoki, 2010; Gopinath et al., 2010, 2011; Goldberg and Hellerstein, 2008; Burstein and Jaimovich, 2009; Atkeson and Burstein, 2008; Auer and Schoenle, 2016; Amiti et al., 2014; Neiman, 2010, 2011; Hellerstein and Villas-Boas, 2010; Iapadre and Pace, 2016; Boudreau and Hagiu, 2009).

Trade is increasingly dominated by firms intermediating between consumers and producers(Baldwin and Venables, 2015; Antras, 2003; Miroudot et al., 2009; OECD, 2013). Tthose firms are increasing their market power (Hong and Li, 2017) and they have the bargaining power to impose LES on their suppliers (Boudreau and Hagiu, 2009). For highly substitutable products, they can also impose compliance costs on upstream suppliers, as shown in Chapter 2.

This paper confirms for public regulations the results of Chapter 2 for private LES. As products become more and more substitutable, a multi-product retailer can shift the cost of compliance to labor and environmental regulation on upstream producers. This results are true for a tax imposed by the producing country on suppliers for a negative externality in production. They are also true for a tax imposed by the consuming country on the retailers for importing products that embed a negative externality, very much like the US Lacey Act.

The model allows to compare public and private regulation driven by consumer preferences. It shows that consumer-driven standards drive a higher level of relative effort for the suppliers, especially when products are more substitutable, compared to the case when formal regulation is imposed on the retailer. For a single-product retailer, though, there is no difference between downstream regulation of the private and public kind. Intuitively, a multi-product retailer is more effective at using product substitutability to its advantage to shift compliance costs on suppliers. The suppliers end up bearing most of the cost of upgrading production when the local regulator imposes a tax directly on the producers.

These results explain why downstream retailers would impose costly voluntary LES on upstream suppliers even when they virtually do not entice any price premium. The introduction of voluntary LES might serve the purpose to delay public regulation protecting labor or the environment that would be relatively more costly on retailers.

In fact, producing countries might be better off by holding off on regulating their economies with labor and environmental standards when downstream stages of the value chain are subject to standards either by public or private regulation. In that case, in fact, downstream firms would contribute more to upgrading the production process. Producing countries, instead, might want to introduce a formal regulation later on, when those production standards have been ratcheted up thanks to foreign investments and the regulation is essentially no more binding for a greater share of firms, a process that seems to be at play in the diffusion of formal labor and environmental regulation across countries.

On the other side, a regulator in the consuming country might also hold off on imposing formal regulation on domestic firms and pressure producing countries to regulate their own economies. For instance, the ILO's Declaration on Fundamental Principles and Rights at Work (1998) and various environmental treaties place the responsibility on producing countries to protect their workers and their natural resources. Similarly, in the presence of consumer activism, the same regulator in the consuming country might also hold off on imposing formal regulation on domestic firms, for instance by requiring a certification of their value chains. When production standards are driven by private regulation, in fact, downstream firms are able assume a lower share of effort, compared to the case when they are formally taxed.

There are also implications for consumers and NGOs in consuming countries. If they are not only concerned with labor and environmental protection, but also with economic inequality, they should pressure regulators to impose LES on retailers rather than opting for market mechanisms. This is how producing countries are the least financially burdened by the introduction of LES.

The policies described in these paper are highly discussed options to impose LES along GVCs. However, they are rarely compared in terms of fairness. How are the costs and benefits of these types of regulation distributed between suppliers and retailers? This paper provides an answer showing that the form taken by LES impacts the distribution of cost of compliance to LES between retailers and suppliers, independently from the distribution of benefits. It shows that even when the benefits from LES are global, for instance environmental intervention that mitigate global warming, the cost of LES can be concentrated on producing, usually poorer, countries.

Chapter 5

Conclusions

The conventional wisdom on the integration of firms into GVCs is that it will provide a channel to faster economic growth as long as institutional barriers do not hamper this process. For this reason many financial and development agencies support policies that connect developing countries with foreign markets and provide the financial assistance to boost their international competitiveness. Critics of this conventional wisdom point out that the expansion of GVCs was accompanied by an increase in global inequality. Traditionally, these critics argue that the globalization of production networks naturally redirects resources towards the firms in the value chain with the most bargaining power which are usually the lead firms located in the developed world, at the expenses of the other members of the value chain, usually located in developing countries.

This thesis finds that the profit distribution between firms in a GVC is skewed in favor of the firms with the highest degree of bargaining power. Additionally, it finds that many policies meant to support producers exacerbate this unequal profit distribution. Overall, these studies imply that trade structure matter for policies, even for locally enforced ones. They show that any policy conditional on trade structure would replicate similar results.

As such, it explains why it would be rational for countries that heavily participate in consumer products GVCs, such as China, to enact policies to influence trade structure, for instance by limiting competition. It also provides an explanation behind voluntary adoption of LES even when they are not supported by higher price premiums. The models I develop in these papers effectively organize current empirical evidence on value captured within GVCs. They provide a framework for further empirical investigation and policies that are better aligned with development goals.

There are multiple ways this simple analysis can be extended. First, these are static models as we assume the structure of the value chain is fixed. Regulation and industry standards can alter the structure of the value chain and change its governance, for instance by creating entry barriers to producers. Integrating these elements into the model can provide more realism. Despite their simplicity, these models are very flexible and show that even in situations were suppliers are monopolists and retailers are not, the multi-product nature of the retailer drives up the share of environmental effort taken on by the supplier. Changes, in the structure of the value chain, then, would not drastically change the basic results and their implications.

Second, the models do not account for branding strategies and differentiation. In that case, consumers might decide not to shop at retailers that have been found deviating on one product line, thereby decreasing profitability over all products sold by the same retailer, instead of having an opposite effect, as outlined in the model presented in this paper. On the other side, differentiation among retailers requires consumers with heterogeneous preferences over the (environmental) qualities of the goods. These models, then, provide an approximation of the effects of similar retailers competing on a market audience with given preferences over such characteristics.

Finally, more work should be devoted to empirically estimate these effects. However, the Global Value Chain literature is dominated by case studies that provide great descriptive richness but lack the external validity and the normative power of a strong theoretical framework. This gap in the academic discourse, which underinforms many policy decisions, is the focus of my research. I believe that this work can help inform policies on how they should adapt to complex market structures.

A Proofs of Chapter 1

A.1 Proof of Proposition 2.5.1

Proof. In a Producer Driven model, proving that $\Pi^*_{j+h} \leq \Pi^*_j$ when $N_j = N_{j+h}$ is equivalent to proving that

$$\frac{1}{\prod_{m=j+h}^{K-1} \delta_m} \prod_{m=j+h+1}^{K} \frac{1+N_m}{N_m} \leq \frac{1}{\prod_{m=j}^{K-1} \delta_m} \prod_{m=j+1}^{K} \frac{1+N_m}{N_m}$$
$$\Rightarrow \prod_{m=j}^{j+h} \delta_m \leq \prod_{m=j}^{j+h} \frac{1+N_m}{N_m}$$

In a Buyer Driven model, proving that $\Pi^*_{j+h} > \Pi^*_j$ when $N_j = N_{j+h}$ is equivalent to proving that:

$$\frac{1}{\prod_{m=1}^{j+h-1} \delta_m} \prod_{m=1}^{j+h-1} \frac{1+N_m}{N_m} \geq \frac{1}{\prod_{m=1}^{j-1} \delta_m} \prod_{m=1}^{j-1} \frac{1+N_m}{N_m}$$
$$\Rightarrow \prod_{m=j-1}^{j+h-1} \delta_m \leq \prod_{m=j-1}^{j+h-1} \frac{1+N_m}{N_m}$$

Both of them are always true given the assumptions.

□

A.2 Proof of Proposition 2.5.2

Proof. In a Producer Driven model, proving that $\Pi^*_j > \Pi^*_{j+1} \, \forall \, j$ is equivalent to the following:

$$\frac{1}{\delta_{j+1}}\frac{1+N_{j+1}}{N_{j+1}}\Big(\frac{N_{j+1}}{N_j}\Big)^2 > 1 \tag{A.1}$$

$$\Leftrightarrow \frac{N_j}{N_{j+1}} < \Big(\frac{1}{\delta_{j+1}}\frac{1+N_{j+1}}{N_{j+1}}\Big)^{\frac{1}{2}} = \bar{m} \tag{A.2}$$

We know that $\frac{1}{\delta_{j+1}} \geq 1$ and we know that $\frac{1+N_{j+1}}{N_{j+1}} \in [1,2]$. Hence, $\bar{m} \geq 1$

In a Buyer Driven model proving that $\Pi^*_{j+1} > \Pi^*_j$ is equivalent to proving that

$$1 < \frac{1}{\delta_j}\frac{1+N_j}{N_j}\Big(\frac{N_j}{N_{j+1}}\Big)^2$$

$$1 < \frac{1}{\delta_j}\frac{1+N_j}{N_j}\Big(\frac{N_j}{N_{j+1}}\Big)^2 \Rightarrow \frac{N_{j+1}}{N_j} < \Big(\frac{1}{\delta_j}\frac{1+N_j}{N_j}\Big)^{\frac{1}{2}} = \bar{n} \tag{A.3}$$

We know that $\frac{1}{\delta_j} \geq 1 \forall j = 1,...,K$ and we know that $\frac{1+N_j}{N_j} \in [1,2]$. Hence, $\bar{n} \geq 1$ □

A.3 Proof of Proposition 2.5.3

Proof. We want to show that in a Producer Driven value chain the following is true:

1. $\frac{\partial \pi_i}{\partial \delta_j} \leq 0 \iff j \geq i$

2. $\frac{\partial \pi_i}{\partial \delta_j} \geq 0 \iff j < i$

3. $\frac{\partial cs}{\partial \delta_j} \geq 0 \forall j$

4. $\frac{\partial ls}{\partial \delta_j} \geq 0 \forall j$

First we need to compute $\pi_i = \frac{\Pi_i}{TS}$, $cs = \frac{CS}{TS}$ and $ls = \frac{LS}{TS}$. It is easy to show using Equations (2.4.13), (2.4.10), (2.4.11) and (2.4.12) that surplus shares are as in Equation (A.4), (A.5), (A.6) respectively when $S = \left(\frac{b+f}{2} + \frac{B}{N_1} + \sum_{j=2}^{K} \frac{b}{N_j} \frac{1}{\prod_{i=j}^{K-1} \delta_i} \prod_{i=j+1}^{K} \frac{N_i+1}{N_1}\right)$.

$$\pi_i = \frac{1}{N_i^2} \frac{b}{\prod_{m=j}^{K-1} \delta_m} \prod_{m=j+1}^{K} \frac{1+N_m}{N_m} S^{-1} \tag{A.4}$$

$$cs = \frac{b}{2} S^{-1} \tag{A.5}$$

$$ls = \frac{f}{2} S^{-1} \tag{A.6}$$

To prove the first claim we need to show that $\frac{\partial \pi_i}{\partial \delta_j} \leq 0 \iff j \geq i$.

When $j \geq i$ we have that:

$$\frac{\partial \pi_i}{\partial \delta_j} = \frac{1}{N_i^2} \frac{b}{\prod_{m=j}^{K-1} \delta_m} \prod_{m=j+1}^{K} \frac{1+N_m}{N_m} \frac{\partial S}{\partial \delta_j} \geq 0 \tag{A.7}$$

$$\iff \frac{\partial S^{-1}}{\partial \delta_j} = -S^{-2} \Big(\frac{1}{N_1} \underbrace{\frac{\partial B}{\partial \delta_j}}_{\leq 0} - \delta_j \underbrace{\sum_{m=2}^{j} \Big(\frac{b}{N_m} \frac{1}{\prod_{i=j}^{K-1} \delta_i} \prod_{i=j+1}^{K} \frac{N_i+1}{N_1} \Big)\Big)}_{\geq 0} \geq 0 \tag{A.8}$$

Note that: $\frac{\partial B}{\partial \delta_j} = -\frac{1}{\delta_j} \frac{b}{\prod_{i=1}^{K-1} \delta_i} \prod_{i=2}^{K} \frac{N_i+1}{N_i} \leq 0$.

We have thus proved the first claim.

To prove the second claim we need to show that $\frac{\partial \pi_i}{\partial \delta_j} \geq 0 \iff j < i$.

When $j < i$ we have that:

$$\frac{\partial \pi_i}{\partial \delta_j} = \frac{1}{N_i^2} b \prod_{m=j+1}^{K} \frac{1+N_m}{N_m}\Big(-\frac{1}{\delta_j}\frac{1}{\prod_{m=j}^{K-1}\delta_m} S^{-1} + \frac{1}{\prod_{m=j}^{K-1}\delta_m}\frac{\partial S^{-1}}{\partial \delta_j} < 0$$
$$= \frac{1}{N_i^2}\frac{b}{\prod_{m=j}^{K-1}\delta_m} \prod_{m=j+1}^{K} \frac{1+N_m}{N_m} S^{-1}\frac{1}{\delta_j}\Big(-1 + S^{-1}\Big(\sum_{m=j}^{K}\frac{b}{N_m}\frac{1}{\prod_{i=1}^{m-1}\delta_i}\prod_{i=1}^{m-1}\frac{N_i+1}{N_i}\Big)\Big)$$

Since $\sum_{m=j}^{K} \frac{b}{N_m}\frac{1}{\prod_{i=1}^{m-1}\delta_i}\prod_{i=1}^{m-1}\frac{N_i+1}{N_i} < S \Leftrightarrow -1+\frac{1}{S}\Big(\sum_{m=j}^{K} \frac{b}{N_m}\frac{1}{\prod_{i=1}^{m-1}\delta_i}\prod_{i=1}^{m-1}\frac{N_i+1}{N_i}\Big) < 0$ which makes $\frac{\partial \pi_i}{\partial \delta_j}$ negative.

To prove the third and fourth claim we need to show that $\frac{\partial cs}{\partial \delta_j} \geq 0$ and $\frac{\partial ls}{\partial \delta_j} \geq 0 \forall j$, which is easy to prove:

$$\frac{\partial cs}{\partial \delta_j} = \frac{b}{2}\frac{\partial S^{-1}}{\partial \delta_j}$$

$$\frac{\partial ls}{\partial \delta_j} = \frac{f}{2}\frac{\partial S^{-1}}{\partial \delta_j}$$

It is easy to see that they are positive once we showed that $\frac{\partial S^{-1}}{\partial \delta_j} \geq 0$ in equation (A.8).

We also want to show that in a Buyer Driven value chain the following is true:

1. $\frac{\partial \pi_i}{\partial \delta_j} \geq 0 \iff j \geq i$

2. $\frac{\partial \pi_i}{\partial \delta_j} \leq 0 \iff j < i$

3. $\frac{\partial cs}{\partial \delta_j} \geq 0 \forall j$

4. $\frac{\partial ls}{\partial \delta_j} \geq 0 \forall j$

First we need to compute $\pi_i = \frac{\Pi_i}{TS}$, $cs = \frac{CS}{TS}$ and $ls = \frac{LS}{TS}$. It is easy to show using equations (2.4.26), (2.4.23), (2.4.24) and (2.4.25) that surplus shares are as in equation (A.9), (A.10), (A.11) respectively when

$$Z = \Big(\frac{b+f}{2} + \frac{F}{N_K} + \sum_{j=1}^{K-1} \frac{f}{N_j} \frac{1}{\prod_{i=1}^{j-1} \delta_i} \prod_{i=1}^{j-1} \frac{N_i+1}{N_1}\Big)$$

.

$$\pi_i = \frac{1}{N_i^2} \frac{f}{\prod_{m=1}^{i-1} \delta_m} \prod_{m=1}^{i-1} \frac{1+N_m}{N_m} Z^{-1} \tag{A.9}$$

$$cs = \frac{b}{2} Z^{-1} \tag{A.10}$$

$$ls = \frac{f}{2} Z^{-1} \tag{A.11}$$

To prove the first claim we need to show that $\frac{\partial \pi_i}{\partial \delta_j} \geq 0 \iff j \geq i$.

When $j \geq i$ we have that:

$$\begin{aligned} \frac{\partial \pi_i}{\partial \delta_j} &= \frac{f}{N_i^2} \prod_{m=1}^{i-1} \frac{N_m+1}{N_m} \Big(- \frac{1}{\delta_j} \frac{1}{\prod_{m=1}^{j-1} \delta_m} Z^{-1} + \frac{1}{\prod_{m=1}^{j-1} \delta_m} \frac{\partial Z^{-1}}{\partial \delta_j} \Big) \\ &= \frac{f}{N_i^2} \prod_{m=1}^{i-1} \frac{N_m+1}{N_m} \frac{1}{\delta_j} \frac{1}{\prod_{m=1}^{j-1} \delta_m} Z^{-1} \Big(-1 + Z^{-1} \Big(\sum_{m=j}^{K} \frac{f}{N_m} \frac{1}{\prod_{n=1}^{m-1} \delta_n} \prod_{n=1}^{m-1} \frac{N_n+1}{N_n} \Big)\Big) \end{aligned}$$

Since

$$\sum_{m=j}^{K} \frac{f}{N_m} \frac{1}{\prod_{n=1}^{m-1} \delta_n} \prod_{n=1}^{m-1} \frac{N_n+1}{N_n} < Z \Leftrightarrow -1 + \frac{1}{Z} \Big(\sum_{m=j}^{K} \frac{f}{N_m} \frac{1}{\prod_{n=1}^{m-1} \delta_n} \prod_{n=1}^{m-1} \frac{N_n+1}{N_n} \Big) < 0$$

and hence $\frac{\partial \pi_i}{\partial \delta_j} < 0$. We have thus proved the first claim.

When $j > i$ we have that:

$$\frac{\partial \pi_i}{\partial \delta_j} = \frac{1}{N_i^2} \frac{f}{\prod_{m=1}^{j-1} \delta_m} \prod_{m=1}^{j-1} \frac{1+N_m}{N_m} \frac{\partial Z^{-1}}{\partial \delta_j} \tag{A.12}$$

Equation (A.12) is positive because $\frac{\partial Z^{-1}}{\partial \delta_j} > 0$. In fact,

$$\frac{\partial Z^{-1}}{\partial \delta_j} = -Z^{-2} \Big(\frac{1}{N_K} \underbrace{\frac{\partial F}{\partial \delta_j}}_{<0} - \frac{1}{\delta_j} \sum_{m=j}^{K-1} \frac{f}{N_m} \prod_{n=1}^{m-1} \frac{N_n+1}{N_n} \frac{1}{\prod_{n=1}^{m-1} \delta_n} \Big) \tag{A.13}$$

Where: $\frac{\partial F}{\partial \delta_j} = -\frac{1}{\delta_j} \frac{f}{\prod_{m=1}^{K-1} \delta_m} \prod_{m=1}^{K-1} \frac{N_m+1}{N_m} < 0$

Based on that, it is easy to prove the last two claims $\frac{\partial cs}{\partial \delta_j} \geq 0$ and $\frac{\partial ls}{\partial \delta_j} \geq 0 \forall j$. In fact, given equation (A.10) and (A.11) and the result of equation (A.13) we have that the following is true:

$$\frac{\partial cs}{\partial \delta_j} = \frac{b}{2} \frac{\partial Z^{-1}}{\partial \delta_j} > 0$$

$$\frac{\partial ls}{\partial \delta_j} = \frac{f}{2} \frac{\partial Z^{-1}}{\partial \delta_j} > 0$$

□

A.4 Proof of Proposition 2.5.4

Proof. We want to show that in a Producer Driven value chain the following is true:

1. $\frac{\partial \pi_i}{\partial N_j} \leq 0 \iff j > i$

2. $\frac{\partial \pi_i}{\partial \delta_j} \geq 0 \iff j < i$

3. $\frac{\partial cs}{\partial \delta_j} \geq 0 \forall j$

4. $\frac{\partial ls}{\partial \delta_j} \geq 0 \forall j$

To prove the first claim, we need to evaluate the derivative $\frac{\partial \pi_i}{\partial N_j}$ when $j > i$.

$$\begin{aligned}
\frac{\partial \pi_i}{\partial N_j} &= \frac{1}{N_i^2} \frac{b}{\prod_{m+i}^{K-1} \delta_m} \Big(-\frac{1}{N_j^2} S^{-1} \prod_{m \in [i+1,K]/\{j\}} \frac{N_m+1}{N_m} + \prod_{m=i+1}^{K} \frac{N_m+1}{N_m} \frac{\partial S^{-1}}{\partial N_j} \Big) \\
&= \frac{1}{N_i^2 N_j^2} \frac{b}{\prod_{m+i}^{K-1} \delta_m} S^{-1} \prod_{m=i+1}^{K} \frac{N_m+1}{N_m} \Big(-\frac{N_j}{N_j+1} + \\
&+ S^{-1} \Big(\frac{1}{N_1} \frac{b}{\prod_{m=1}^{K-1} \delta_m} \prod_{m \in [2,K]/\{j\}} \frac{N_m+1}{N_m} + \sum_{m=2}^{j} \frac{b}{\prod_{n=i}^{K-1} \delta_n} \prod_{n=i+1}^{K} \frac{N_n+1}{N_n} \frac{N_j}{N_m} \Big) \Big) \\
&< 0
\end{aligned}$$

Where the result stems from substituting equation (A.14) and (A.15) into $\frac{\partial \pi_i}{\partial N_j}$

$$\frac{\partial S^{-1}}{\partial N_j} = -S^{-2} \Big(\frac{1}{N_1} \frac{\partial B}{\partial N_j} + \frac{1}{N_m^2} \sum_{m=2}^{j} \frac{b}{\prod_{n=i}^{K-1} \delta_n} \prod_{n=i+1}^{K} \frac{N_n+1}{N_n} \frac{N_j}{N_i} \Big) \geq 0 \tag{A.14}$$

$$\frac{\partial B}{\partial N_j} = -\frac{1}{N_j^2} \frac{b}{\prod_{m=1}^{K-1} \delta_m} \prod_{m \in [2,K]/\{j\}} \frac{N_m+1}{N_m} \leq 0 \tag{A.15}$$

To prove the second, third and fourth claim, we need to evaluate the derivative $\frac{\partial \pi_i}{\partial N_j}$ when $j >\leq i$, $\frac{\partial cs}{\partial \delta_j}$ and $\frac{\partial ls}{\partial \delta_j}$. In that case, given the sign of equation (A.14) it is easy to see the derivatives are positive.

$$\frac{\partial \pi_i}{\partial N_j} = \frac{1}{N_i^2} \frac{b}{\prod_{m+i}^{K-1} \delta_m} \prod_{m=i+1}^{K} \frac{N_m+1}{N_m} \frac{\partial S^{-1}}{\partial N_j} \geq 0$$

$$\frac{\partial cs}{\partial N_j} = \frac{b}{2} \frac{\partial S^{-1}}{\partial N_j} \geq 0$$

$$\frac{\partial ls}{\partial N_j} = \frac{f}{2} \frac{\partial S^{-1}}{\partial N_j} \geq 0$$

We also want to show that in a Buyer Driven value chain the following is true:

1. $\frac{\partial \pi_i}{\partial N_j} \geq 0 \iff j > i$

2. $\frac{\partial \pi_i}{\partial \delta_j} \leq 0 \iff j < i$

3. $\frac{\partial cs}{\partial \delta_j} \geq 0 \forall j$

4. $\frac{\partial ls}{\partial \delta_j} \geq 0 \forall j$

To prove the first claim we need to evaluate $\frac{\partial \pi_i}{\partial N_j}$ when$j > i$:

$$\frac{\partial \pi_i}{\partial N_j} = \frac{1}{N_i^2} \frac{f}{\prod_{m=1}^{i-1} \delta_m} \prod_{m=1}^{i-1} \frac{N_m + 1}{N_m} \frac{\partial Z^{-1}}{\partial N_j} \geq 0 \tag{A.16}$$

Equation (A.16) is positive, given the results of equations (A.17) and (A.18).

$$\frac{\partial Z^{-1}}{\partial N_j} = -Z^{-2} \Big(\frac{1}{N_K} \frac{\partial F}{\partial N_j} - \frac{1}{N_j^2} \sum_{m=j}^{K-1} \frac{f}{\prod_{n=1}^{m-1} \delta_n} \prod_{n=1}^{m-1} \frac{N_n + 1}{N_n} \frac{N_j}{N_m} \Big) > 0 \tag{A.17}$$

$$\frac{\partial F}{\partial N_j} = -\frac{1}{N_j^2} \frac{f}{\prod_{m=1}^{K-1} \delta_m} \prod_{m \in [1, K-1]/\{j\}} \frac{N_m + 1}{N_m} < 0 \tag{A.18}$$

To prove the second claim we need to evaluate $\frac{\partial \pi_i}{\partial N_j}$ when$j < i$ and it is easy to see it is negative:

$$
\begin{aligned}
\frac{\partial \pi_i}{\partial N_j} \quad &= \frac{1}{N_i^2}\frac{f}{\prod_{m=1}^{j-1}\delta_m}\prod_{m\in[1,i-1]/\{j\}}\frac{N_m+1}{N_m}\Big(-\frac{1}{N_j^2}Z^{-1}+\frac{N_j+1}{N_j}\frac{\partial Z^{-1}}{\partial N_j}\Big)\\
&= \frac{1}{N_i^2N_j^2}\frac{f}{\prod_{m=1}^{j-1}\delta_m}\prod_{m=1}^{j-1}\frac{N_m+1}{N_m}Z^{-1}\Big(-\frac{N_j}{N_j+1}+\\
&+Z^{-1}\Big(\frac{1}{N_K}\frac{f}{\prod_{m=1}^{K-1}\delta_m}\prod_{m\in[1,K-1]/\{j\}}\frac{N_m+1}{N_m}+\sum_{m=j}^{K-1}\frac{f}{\prod_{n=1}^{m-1}\delta_n}\prod_{n=1}^{m-1}\frac{N_n+1}{N_n}\frac{N_j}{N_m}\Big)\Big)\\
&\leq 0
\end{aligned}
$$

Finally, to prove the third and fourth claim we need to evaluate $\frac{\partial cs}{\partial N_j}$ and $\frac{\partial ls}{\partial N_j}$ and it is easy to see they are positive given equation (A.17).

$$
\begin{aligned}
\frac{\partial cs}{\partial N_j} &= \frac{b}{2}\frac{\partial Z^{-1}}{\partial N_j} \geq 0\\
\frac{\partial ls}{\partial N_j} &= \frac{f}{2}\frac{\partial Z^{-1}}{\partial N_j} \geq 0
\end{aligned}
$$

□

A.5 Proof of Proposition 2.5.5

Proof. It is trivial to check that in both Producer Driven and Buyer Driven value chains the derivative of surplus shares with respect to a are equal to zero and hence prove the first claim of Proposition 2.5.5.

For the rest of Proposition 2.5.5, we need to prove that in a Producer Driven value chain the following is true:

1. $\frac{\partial \pi_i}{\partial b} \geq 0$

2. $\frac{\partial cs}{\partial b} \geq 0$

3. $\frac{\partial ls}{\partial b} \leq 0$

$$\begin{aligned}\frac{\partial \pi_i}{\partial b} &= \frac{1}{N_i^2} \prod_{m=i+1}^{K} \frac{N_m + 1}{N_m} \frac{1}{\prod_{m=i}^{K-1} \delta_m} \Big(S^{-1} + b \frac{\partial S^{-1}}{\partial b} \Big) \\ &\geq 0\end{aligned}$$

It is easy to show that $\frac{\partial \pi_i}{\partial b}$ is positive given the results of equation (A.19) and (A.20).

$$\frac{\partial S^{-1}}{\partial b} = -S^{-2} \Big(\frac{1}{2} + \frac{1}{N_1} \frac{\partial B}{\partial b} + \sum_{m=2}^{K} \frac{1}{N_m \prod_{n=m}^{K-1} \delta_n} \prod_{n=m+1}^{K} \frac{N_n + 1}{N_n} \Big) \leq 0 \tag{A.19}$$

$$\frac{\partial B}{\partial b} = \frac{1}{\prod_{m=1}^{K-1} \delta_m} \prod_{m=2}^{K} \frac{N_m + 1}{N_m} \geq 0 \tag{A.20}$$

It is also easy to show the sign of $\frac{\partial cs}{\partial b}$ and $\frac{\partial ls}{\partial b}$ are negative given equation (A.19).

$$\frac{\partial ls}{\partial b} = \frac{f}{2} \frac{\partial S^{-1}}{\partial b} \leq 0$$

$$\begin{aligned}\frac{\partial cs}{\partial b} &= \frac{1}{2} S^{-1} + \frac{b}{2} \frac{\partial S^{-1}}{\partial b} \\ &= \frac{1}{2} S^{-1} \Big(1 - S^{-1} b \Big(\frac{1}{2} + \frac{1}{N_1} \frac{\partial B}{\partial b} + \sum_{m=2}^{K} \frac{1}{N_m \prod_{n=m}^{K-1} \delta_n} \prod_{n=m+1}^{K} \frac{N_n + 1}{N_n} \Big) \Big) \\ &\geq 0\end{aligned}$$

We also need to prove that in a Buyer Driven value chain the following is true:

1. $\frac{\partial \pi_i}{\partial b} \geq 0$

2. $\frac{\partial cs}{\partial b} \geq 0$

3. $\frac{\partial ls}{\partial b} \leq 0$

We can easily compute $\frac{\partial \pi_i}{\partial b}$ and show that is negative, given Equation A.21.

$$\frac{\partial \pi_i}{\partial b} = \frac{1}{N_i^2} \frac{f}{\prod_{m=1}^{i-1} \delta_m} \prod_{m=1}^{i-1} \frac{N_m + 1}{N_m} \frac{\partial Z^{-1}}{\partial b} \leq 0$$

$$\frac{\partial Z^{-1}}{\partial b} = -Z^{-2}\Big(\frac{1}{2} + \frac{1}{N_K} \underbrace{\frac{\partial F}{\partial b}}_{=1}\Big) \tag{A.21}$$

Using Equation A.21 we can also easily prove the last two claims:

$$\frac{\partial ls}{\partial b} = \frac{f}{2} \frac{\partial Z^{-1}}{\partial b} \leq 0$$

$$\begin{aligned} \frac{\partial cs}{\partial b} &= \frac{1}{2}\Big(Z^{-1} + b\frac{\partial Z^{-1}}{\partial b}\Big) \\ &= \frac{1}{2} Z^{-1}\Big(1 - Z^{-1}\Big(\frac{b}{2} + \frac{b}{N_K}\Big)\Big) \geq 0 \end{aligned}$$

□

A.6 Proof of Proposition 2.5.6

Proof. It is trivial to check that in both Producer Driven and Buyer Driven value chains the derivative of surplus shares with respect to c are equal to zero and hence prove the first claim of Proposition 2.5.6.

For the rest of Proposition 2.5.6, we need to prove that in a Producer Driven value chain the following is true:

1. $\frac{\partial \pi_i}{\partial f} \leq 0$

2. $\frac{\partial cs}{\partial f} \leq 0$

3. $\frac{\partial ls}{\partial f} \geq 0$

First, lets evaluate $\frac{\partial \pi_i}{\partial f}$.

$$\frac{\partial \pi_i}{\partial f} = \frac{1}{N_i^2} \frac{b}{\prod_{m=i}^{K-1} \delta_m} \prod_{m=i+1}^{K} \frac{N_m + 1}{N_m} \frac{\partial S^{-1}}{\partial f} \leq 0 \tag{A.22}$$

It is easy to see that equation (A.22) is negative given equation (A.23).

$$\frac{\partial S^{-1}}{\partial f} = -S^{-2}\Big(\frac{1}{2} + \frac{1}{N_1} \underbrace{\frac{\partial B}{\partial b}}_{=1}\Big) \leq 0 \tag{A.23}$$

Given equation (A.23) we can also easily prove the last two claims:

$$\frac{\partial cs}{\partial f} = \frac{b}{2} \frac{\partial S^{-1}}{\partial f} \leq 0$$

$$\begin{aligned} \frac{\partial ls}{\partial f} &= \frac{1}{2}\Big(S^{-1} + f\frac{\partial S^{-1}}{\partial f}\Big) \\ &= \frac{1}{2} S^{-1}\Big(1 - S^{-1}\Big(\frac{f}{2} + \frac{f}{N_1}\Big)\Big) \geq 0 \end{aligned}$$

We also need to prove that in a buyer driven model the following is true:

1. $\frac{\partial \pi_i}{\partial f} \geq 0$

2. $\frac{\partial cs}{\partial f} \leq 0$

3. $\frac{\partial ls}{\partial f} \geq 0$

$$\begin{aligned}\frac{\partial \pi_i}{\partial f} &= \frac{1}{N_i^2}\frac{1}{\prod_{m=1}^{i-1}\delta_m}\prod_{m=1}^{i-1}\frac{N_m+1}{N_m}\Big(Z^{-1}+f\frac{\partial Z^{-1}}{\partial f}\Big)\\ &= \frac{1}{N_i^2}\frac{1}{\prod_{m=1}^{i-1}\delta_m}\prod_{m=1}^{i-1}\frac{N_m+1}{N_m}Z^{-1}\Big(1-\\ &+Z^{-1}\Big(\frac{f}{2}+\frac{1}{N_K}\frac{f}{\prod_{m=1}^{K-1}\delta_m}\prod_{m=1}^{K-1}\frac{N_m+1}{N_m}+\sum_{m=1}^{K-1}\frac{1}{N_m}\frac{f}{\prod_{n=1}^{m-1}\delta_n}\prod_{m=1}^{n-1}\frac{N_n+1}{N_n}\Big)\Big)\\ &\geq 0\end{aligned}$$

It is easy to show that $\frac{\partial \pi_i}{\partial f} \geq 0$ given equation (A.24) and (A.25).

$$\frac{\partial Z^{-1}}{\partial f} = -Z^{-2}\Big(\frac{1}{2}+\frac{1}{N_K}\frac{\partial F}{\partial b}+\sum_{m=1}^{K-1}\frac{1}{N_m}\frac{1}{\prod_{n=1}^{m-1}\delta_n}\prod_{m=1}^{n-1}\frac{N_n+1}{N_n}\Big) \leq 0 \tag{A.24}$$

$$\frac{\partial F}{\partial f} = \frac{1}{\prod_{m=1}^{K-1}\delta_m}\prod_{m=1}^{K-1}\frac{N_m+1}{N_m} \geq 0 \tag{A.25}$$

Given Equation A.24 and A.25 it is also easy to prove the last two claims.

$$\frac{\partial cs}{\partial f} = \frac{b}{2}\frac{\partial Z^{-1}}{\partial f} \leq 0$$

$$\begin{aligned}\frac{\partial ls}{\partial f} &= \frac{1}{2}\Big(Z^{-1}+f\frac{\partial S^{-1}}{\partial f}\Big)\\ &= \frac{1}{2}Z^{-1}\Big(1-Z^{-1}\Big(\frac{1}{2}+\frac{1}{N_K}\frac{\partial F}{\partial b}+\sum_{m=1}^{K-1}\frac{1}{N_m}\frac{1}{\prod_{n=1}^{m-1}\delta_n}\prod_{m=1}^{n-1}\frac{N_n+1}{N_n}\Big)\Big) \geq 0\end{aligned}$$

□

B When the Length of the Value Chain is Endogenous

To simplify the intuition behind this result, take as an example a Buyer Driven value chain with two stages of production as in Section 2.3.2. Given this value chain structure, this section will compare the extreme values that competition can take at each stage: with each stage being either perfectly competitive or a monopoly.

When $N_1 = 1 = N_2 \Leftrightarrow \Pi_2^* > \Pi_1^*$. In fact:

- $\Pi_2^* = \frac{1}{4}(a - \frac{c}{\delta_1})^2(b + \frac{2f}{\delta_1})^{-1}$
- $\Pi_1^* = \frac{1}{2}\frac{f}{\delta_1}(a - \frac{c}{\delta_1})^2(b + \frac{2f}{\delta_1})^{-2}$

When $N_1 \to \infty$ $N_2 = 1 \Leftrightarrow \Pi_2^* > \Pi_1^*$. In fact:

- $\Pi_2^* \to \frac{1}{4}(a - \frac{c}{\delta_1})^2(b + \frac{f}{\delta_1})^{-1}$
- $\Pi_1^* \to 0$

When $N_1 = 1$ $N_2 \to \infty \Leftrightarrow \Pi_2^* < \Pi_1^*$. In fact:

- $\Pi_2^* \to 0$
- $\Pi_1^* \to f(a - \frac{c}{\delta_1})^2(b + \frac{f}{\delta_1})^{-2}$

When $N_1 \to$ $N_2 \to \infty \Leftrightarrow \Pi_2^* = \Pi_1^*$. In fact:

- $\Pi_2^* \to 0$
- $\Pi_1^* \to 0$

We show that having a monopoly downstream in a Buyer Driven model always drives more aggregate profits for the firms in a value chain and so, even when the last stage of a Buyer Driven value chain is perfectly competitive, upstream firms would be better off buying those firms. Conversely, when an upstream stage is perfectly competitive, there is not much of an advantage for downstream firms from internalizing upstream production. The contrary is true for a Producer Driven value chain. In other words, market power is always going to concentrate at the downstream end of a Buyer Driven value chain and at the upstream end in a Producer Driven value chain. This is true because lead firms have two sources of markup: the ability to act as a monopolist with respect to downstream actors and monopsonists with respect to upstream actors simultaneously. Every other stages of production have only one source of markup.

Formally, it is easy to show that $\Pi_1^*|_{N_1=1,N_2\to\infty} \leq \Pi^*|_{N=1}$, where $\Pi_1^*|_{N_1,N_2}$ represent the individual profits of firms at stage one of a Buyer Driven value chain with two production stages depending on the number of competitors at each stage N_1 and N_2, while $\Pi^*|_N$ represents the profits of an individual firm in a Buyer Driven value chain with only one stage as a function of N, the number of competing firms at that production stage.

In fact: $\Pi_1^*|_{N_1=1,N_2\to\infty} \leq \Pi^*|_{N=1} \Leftrightarrow \frac{f}{\delta_1}(b+\frac{2f}{\delta_1})^{-2} \leq \frac{1}{4}(b+\frac{f}{\delta_1})^{-1} \Leftrightarrow 0 \leq b^2$. The last statement is always true.

We are also going to show that in a Buyer Driven value chain with two stages of production with one firm per stage, both firms will have an incentive to buy the other one, hence the value chain will tend to naturally shrink. Also, we will show that net of any differences in difficulties of finding credit, the upstream firm always has a greater incentive to buy the downstream firm because the increase in profits for the former is greater than the increase for the latter.

Formally,

$$\Pi^*|_{N=1} - \Pi_1^*|_{N_1=1,N_2=1} \geq 0 - \Pi_2^*|_{N_1=1,N_2=1} \Leftrightarrow \Pi^*|_{N=1} \geq \Pi_1^*|_{N_1=1,N_2=1} - \Pi_2^*|_{N_1=1,N_2=1}$$

The last statement is always true because in a Buyer Driven value chain $\Pi_1^*|_{N_1=1,N_2=1} - \Pi_2^*|_{N_1=1,N_2=1} \leq 0$. This proves the first claim: the upstream firm has an incentive to buy the downstream firm.

It is also easy to show that the downstream firm has an incentive to buy the upstream firm:

$$\Pi^*|_{N=1} - \Pi_2^*|_{N_1=1,N_2=1} \geq 0 - \Pi_1^*|_{N_1=1,N_2=1} \Leftrightarrow \Pi^*|_{N=1} \geq \Pi_2^*|_{N_1=1,N_2=1} - \Pi_1^*|_{N_1=1,N_2=1}$$

A bit of algebra will show that this statement is always true.

Finally, the upstream firm has a greater incentive to buy the downstream firm than the other way around in a Buyer Driven value chain. In fact:

$$\Pi^*|_{N=1} - \Pi_1^*|_{N_1=1,N_2=1} + \Pi_2^*|_{N_1=1,N_2=1} \geq \Pi^*|_{N=1} - \Pi_2^*|_{N_1=1,N_2=1} + \Pi_1^*|_{N_1=1,N_2=1}$$

. This statement is always true.

C Comparing the model in Chapter 1 to the Non-Linear Value Chain of Chapter 2

As in Chapter 2 we are going to assume a consumer utility function of the form $U = \sum_{k=1}^{J} q_k^{\rho}$, where J is the number of goods available, q_k is the quantity of each good $k \in [1, J]$ purchased and $\rho_K \in (0, 1)$ is the degree of substitutability of final goods, with 0 indicates complementary products and 1 substitutable products. Given the budget constraint of the consumers $Y = \sum_{k=1}^{J} p_k q_k$, where Y is total income and p_k is the price of final product k, the demand for each final product is as in equation (C.1), where G is the price index $G = \sum_{j=1}^{J} p_j^{\frac{\rho}{\rho-1}}$.

$$q_k = \frac{Y}{G} p_k^{\frac{1}{\rho_K - 1}} \tag{C.1}$$

Multiple identical retailers (N_K) sell all those J partially substitutable products at price p_j set optimally to maximize their profits $\pi_K = \sum_{j=1}^{J} p_j q_{j,K} - \delta_K g_j q_{j,K} - F$, where $q_{j,K}$ is the quantity sold by the retailer of good j, $\delta_K \geq 1$ is the iceberg transportation cost to bring the good from production stage $K-1$ to K and g_j is the wholesale price of good j.

The problem of each retailer is:

$$\begin{aligned} \underset{q_{j,K}}{\text{maximize}} \quad & \pi_K \\ \text{subject to} \quad & q_{j,K} = q_j - \sum_{l \in [1, N_K]/l} q_{j,k} \end{aligned}$$

And we get that optimal pricing is:

$$p_j = \frac{\frac{1}{\rho_K - 1}}{\frac{\rho_K}{\rho_K - 1} - \frac{N_K - 1}{N_K}} \delta_K g_j = \beta_K \delta_K g_j \tag{C.2}$$

There are multiple identical suppliers of q_j, specifically N_{K-1} of them and they produce good j using multiple components, that once again are partially substitutable according to parameter $\rho_{K-1} \in (0,1)$, components that are shipped at transportation cost δ_{K-1}, identical across components. Suppiers maximize a profit function:

$$\pi_{i,j} = (p_i - c_i) q_{i,j} = (g_j - \delta_{K-1} c_j) \Big(\frac{Y}{G} p_j^{\frac{1}{\rho_K - 1}} - \sum_{l=1}^{N_i - 1} q_{i,l} \Big) \tag{C.3}$$

We assume all N_i producers are identical, have the same cost structure $c_{i,j} = c_i$.

Substituting the price previously found into the demand function, so that the profits of the suppliers, their problem is to maximise their profits:

$$\underset{g_j}{\text{maximize}} \quad \pi_{i,j}$$

Which yields optimal price of:

$$g_{j,K-1} = \frac{\frac{1}{\rho_{K-1}-1}}{\frac{\rho_{K-1}}{\rho_{K-1}-1} - \frac{N_j-1}{N_j}} c_j = \beta_{K-1}\delta_{K-1}c_j \tag{C.4}$$

By reiterating in the same fashion for all K stages of production we get that the final optimal price for good j is:

$$p_j^* = c_j \prod_{k=1}^{K} \beta_k \delta_k \tag{C.5}$$

Final profits are obtained by substituting the final price and wholesale prices it into the profit functions. This means that the equilibrium profits are:

$$\pi_{j,k}^* = (g_{j,k} - \delta_k g_{j,k-1})\Big(\frac{Y}{N_i G}(c_j \prod_{k=1}^{K} \beta_k \delta_k)^{\frac{1}{\rho_K - 1}}\Big) \tag{C.6}$$

$$\pi_{j,K}^* = (p_i^* - \delta_K g_{j,K-1})\Big(\frac{Y}{N_K G}(c_j \prod_{k=1}^{K} \beta_k \delta_k)^{\frac{1}{\rho_K - 1}}\Big) \tag{C.7}$$

Total industry profits are obtained by summing up all profits of all firms at all stages of production. Total industry profits for product i become:

$$\Pi_j = \sum_{k=1}^{K} \sum_{i=1}^{N_k} \pi_{i,k}^* \tag{C.8}$$

Which means that the percentage of the total profits of each firm at the two stages are:

$$\pi_{j,k}^{\%} = \frac{\pi_{j,k}^{*}}{\Pi_j} \tag{C.9}$$

All of the following propositions can easily been proven by taking the derivatives of equation (C.9) with respect to the variable in question.

Proposition C.1. *An upstream decrease in trade costs makes firms worse off in relative terms, while a downstream decrease in trade costs makes firms gain in relative terms. In other words:*

1. $\frac{\partial \pi_{i,k}^{\%}}{\partial \delta_j} \geq 0 \iff j \leq k$
2. $\frac{\partial \pi_{i,k}^{\%}}{\partial \delta_j} \leq 0 \iff j > k$

Proposition C.2. *An upstream and a downstream increase in competition makes a firm better off, i.e.* $\frac{\partial \pi_{i,k}^{\%}}{\partial N_j} \geq 0 \forall j \neq k$*. The impact of the increase in competition depends on the initial levels of competition:* $\frac{\partial \pi_{i,k}^{\%}}{\partial N_j} > \frac{\partial \pi_{i,k}^{\%}}{\partial N_m} \iff N_j < N_m$.

Proposition C.3. *An increase in the elasticity of demand, driven by an increase in the degree of substitutability among product varieties increases the relative profits for upstream firms, but not for downstream firms.*

D Proofs of Chapter 2

D.1 Proof of the statements in Section 4.2.4 and Section 4.2.4.1

Proof of the statements in Section 4.2.4 and Section 4.2.4.1. :

First order condition of the maximization problems (3.3.15) and (3.3.16) are:

$$\frac{\partial\pi_r(e_{i,j},e_{r,j})}{\partial e_{r,j}} = \frac{\partial\pi_r}{\partial\Gamma}\frac{\partial\Gamma(e_{i,j},e_{r,j})}{\partial e_{r,j}} - \frac{\partial R(e_{r,j})}{\partial e_{r,j}} = 0$$
$$\Rightarrow \frac{\partial\Gamma(e_{i,j},e_{r,j})}{\partial e_{r,j}} = \frac{\partial R(e_{r,j})}{\partial e_{r,j}}\Big(\frac{\partial\pi_r(e_{i,j},e_{r,j})}{\partial\Gamma}\Big)^{-1}$$
$$\Rightarrow -\gamma a(1-e_{r,j})^{a-1} = \frac{\partial R(e_{r,j})}{\partial e_{r,j}}\Big(\frac{\partial\pi_r(e_{i,j},e_{r,j})}{\partial\Gamma}\Big)^{-1}$$

$$-\gamma b(1-e_{i,j})^{b-1} = \frac{\partial S(e_{i,j})}{\partial e_{i,j}}\Big(\frac{\partial\pi_{i,j}(e_{i,j},e_{r,j})}{\partial\Gamma}\Big)^{-1}$$

Knowing that the derivative with respect to Γ of the profit functions of equation (3.3.12) and (3.3.13) are expressed by equations (F.5) and (F.4).

$$\frac{\partial\pi^*_{i,j}}{\partial\Gamma} = (\beta_j-1)c_j\frac{Y}{G}(\beta_r\beta_jc_j)^{\frac{1}{\rho-1}}z_j^{\frac{\gamma}{1-\rho}}log(z_j)\frac{\partial_{e_{i,j}}\Gamma}{1-\rho} \tag{D.1}$$

$$\frac{\partial\pi^*_r}{\partial e_{r,j}} = (\beta_k-1)\beta_jc_j\frac{Y}{G}(\beta_r\beta_jc_j)^{\frac{1}{\rho-1}}z_j^{\frac{\gamma}{1-\rho}}log(z_j)\frac{\partial_{e_{i,j}}\Gamma}{1-\rho} - \\ + \frac{\partial G}{\partial e_{r,j}}\sum_{k=1}^{J}(\beta_r-1)\beta_kc_K(\frac{Y}{G^2}(\beta_r\beta_kc_k)^{\frac{1}{\rho-1}}z_k^{\frac{\gamma}{1-\rho}})$$

Taking the ration of the result of the optimization conditions and substituting equations (F.5) and (F.4), we get the relative environmental effort function (3.3.17).

□

D.2 Proofs of Results Section

Proof of Proposition 3.4.1. The proposition follows from comparing the profits of retailer and suppliers on product line j, without considering fixed costs of operation.

$$\pi_{r,j} > \pi_{i,j} \iff (\beta_r - 1)\beta_j c_j \frac{q_j}{R} > (\beta_j - 1)c_j \frac{q_j}{R}$$
$$\iff \frac{N_j^2 - R^2}{R} > \rho - 1$$

Given that N_j and R are integers, this statement is always true as long as $N_j \geq R$

□

Proof of Proposition 3.4.2. Proposition 3.4.2 stems from comparing equation (4.2.11) and (4.2.10). It is easy to see that the first component of equation (4.2.11) is greater in absolute value than equation (4.2.10) and it follows from proof of Proposition 3.4.1. Nevertheless the second positive component of equation (4.2.11) counterbalances the first one. For instance, assuming that $N_j = N = R \, \forall j \in [1, J]$ and $c_j = c \, \forall j \in [1, J]$, it is easy to show that the first component dominates the second component only for low levels of ρ. □

Proof Proposition 3.4.3 and Proposition 3.4.4. It is easy to see from equation (4.2.13) and Figure 4.2b that as long as $N_j \geq R$, $\partial_{e_{i,j}} S(e_{i,j}) = \partial_{e_{r,j}} R(e_{r,j})$ and $a = b$,

$$lim_{\rho \to 0} \frac{(1 - e_{i,j})^{b-1}}{(1 - e_{r,j})^{a-1}} = \infty \Rightarrow lim_{\rho \to 0} e_{r,j} = 1 \, \forall e_{i,j} \in [0, 1)$$

and

$$lim_{\rho \to 1} \frac{(1 - e_{i,j})^{b-1}}{(1 - e_{r,j})^{a-1}} = 0 \Rightarrow lim_{\rho \to 1} e_{i,j} = 0 \, \forall e_{r,j} \in [0, 1)$$

However, if we abstract from the second component of the sum of equation (4.2.13), we assume that the retailer has no profit increase driven by the higher sales of products higher than j, i.e. set $\frac{\rho}{(\beta_j - 1)c_j}(\frac{\beta_r \beta_j c_j}{1 - t_j})^{\rho}(1 - \frac{1}{\beta_r})$ equal to zero. It is easy to see in that case that while for complementary products in the limit the results do not change, for substitutable products it does, in fact:

$$lim_{\rho\to 0}\frac{(1-e_{i,j})^{b-1}}{(1-e_{r,j})^{a-1}} = \infty \Rightarrow lim_{\rho\to 0}e_{r,j} = 1\,\forall e_{i,j}\in[0,1)$$

and

$$lim_{\rho\to 1}\frac{(1-e_{i,j})^{b-1}}{(1-e_{r,j})^{a-1}} = 1 \Rightarrow lim_{\rho\to 1}e_{i,j} = e_{r,j}\,\forall e_{r,j}\in[0,1)$$

It is also easy to see from equation (4.2.13), that in both cases, as $\frac{\partial_{e_{i,j}}S(e_{i,j})}{\partial_{e_{r,j}}R(e_{r,j})}$ increases (decreases), i.e. as the marginal unit of environmental effort for the supplier becomes more (less) costly compared to the retailers', the effort of the retailer increases (decreases). Similarly, as the $\frac{a}{b}$ increases (decreases), i.e. the effectiveness of the marginal unit of effort by the supplier relative to the retailers' decreases (increases), the retailers' effort increases (decreases). This is true for both a multi-product and a single-product retailer.

Finally, equation (4.2.13) shows that taking everything else as constant, as N_j increases (decreases), $\frac{(1-e_{i,j})^{b-1}}{(1-e_{r,j})^{a-1}}$ goes up (down) and with it goes the relative effort of the retailers compared to the suppliers. Similarly, when R increases (decreases), $\frac{(1-e_{i,j})^{b-1}}{(1-e_{r,j})^{a-1}}$ goes down (up) and with it goes the relative effort of the retailer compared to that of the suppliers.

□

E The Double Marginalization Problem and Its Impact on Relative Upgrading Effort

The models in Chapter 2 and Chapter 3 give rise to a double marginalization problem: when products are less than perfectly substitutable and when the stages in the value chain is not perfectly competitive the compound mark up is higher than the optimal markup in a vertically integrated scenario. Aggregate profits per product line, therefore, are lower than under vertical integration, as demand decreases in own price.

One of the solutions to this problem is vertical integration: the retailer buying the supplier and producing the good in-house. In this case, the retailer would have access to information about the cost of production c_j and pick an optimal price, thus avoiding the double marginalization problem. However, vertical integration is not always costless and while the results of the previous model easily extend to that scenario, it would not allow to investigate the question of the division of environmental effort and their cost among members of a value chain (Gereffi et al., 2005; Antràs and Chor, 2013).

Another commonly proposed option to avoid the double marginalization problem is a transfer from retailers to suppliers in exchange for selling the goods at cost. That transfer would be at least of the amount of the suppliers' forgone profits, making it profitable for suppliers to accept the deal. However, if retailers do not know production costs c_j, there is an incentive for the suppliers to misrepresent their unit costs and still charge a markup while receiving the transfer. Obviously, the opposite exchange is feasible as well: the suppliers make a transfer to the retailers in exchange for pricing at wholesale costs. In this case there would be no issue of deviating from the contract, as consumer prices tend to be public providing suppliers with the information to enforce the contract. While this strategy is profitable when suppliers competition is milder compared to retailers competition, as it is the case for capital intensive industries, this is less the case for consumer goods.

E.0.1 Model Without Double Marginalization

When upstream competition is fiercer than downstream competition, the solution to the double marginalization problem consists in a contract between the supplier and the retailer where they fix a retail price and the retailer agrees to cede a fraction α of that unit price to the supplier. The optimal retail price under the contract is $p_j^C = \beta_r c_j^C$, the same as in equation (3.3.7), where c_j^C is the unit cost as communicated by the supplier. The problem of the supplier, then, is to find the value of α that induces truthful revelation on the part of the supplier: $c_j^{C*} = c_j$.

The wholesale price becomes $g_j^C = \alpha\beta_r c_j^C$ and the problem of supplier i of good j is now finding the profit maximizing marginal cost as communicated to the retailer c_j^{C*}, given that final demand is downward sloping, that its elasticity is determined by ρ and given the contract proposed by the retailer.

$$\begin{aligned} \underset{c_j^C}{\text{maximize}} \quad & \pi_{i,j}^C = (\alpha\beta_r c_j^C - c_j) q_{i,j}(\beta_r c_j^C) \\ \text{subject to} \quad & q_{i,j} = \frac{Y}{G}(\beta_r g_j)^{\frac{1}{\rho-1}} - \sum_{s\in[1,J]/i} q_{s,j} \end{aligned} \tag{E.1}$$

First order conditions give us optimal marginal cost communication of the form of equation (E.2). It follows that the level of α that induces truthful revelation of unit costs c_j is as expresses in equation (E.3).

$$c_j^{C,*} = \frac{\frac{1}{\rho-1}}{\frac{\rho}{\rho-1} - \frac{N_j-1}{N_j}} \frac{c_j}{\alpha\beta_r} = \frac{\beta_j}{\alpha\beta_r} c_j \tag{E.2}$$

$$\alpha^* = \frac{\beta_j}{\beta_r} = \frac{\frac{\frac{1}{\rho-1}}{\frac{\rho}{\rho-1} - \frac{N_i-1}{N_i}}}{\frac{\frac{1}{\rho-1}}{\frac{\rho}{\rho-1} - \frac{R-1}{R}}} = \frac{\frac{\rho}{\rho-1} - \frac{R-1}{R}}{\frac{\rho}{\rho-1} - \frac{N_i-1}{N_i}} \tag{E.3}$$

This level of α display some desirable properties:

1. $\alpha < 1$ if an only if $\beta_j < \beta_r$ which means that for every ρ it must be the case that $R < N_j$. This is because, in order for the contract to be attractive to the supplier, the retailer needs to have a high market share and hence price premium, at least greater than the supplier.

2. It belongs to the interval $[0, 1]$. In fact, given the initial assumption that $R < N_j$, it follows that $\beta_r \geq \beta_j \Rightarrow 0 \leq \alpha^* \leq 1$.

3. When goods are perfect complements, the level of α is determined by the level of competition $\lim_{\rho\to 0} \alpha^* = \frac{\frac{R-1}{R}}{\frac{N_j-1}{N_j}}$, and when $R \to 1$ then $\alpha \to 0$

4. When goods are perfect substitutes $\lim_{\rho\to 1} \alpha = 1$, then price is equal to marginal cost, so the suppliers get the whole share of zero profits.

5. A perfectly competitive retailer drives α to one: $\lim_{R\to\infty} \alpha^* = 1$. Once again, as a perfectly competitive retailer does not yield a markup, the supplier gets the whole share of zero profits. It is good to remember the assumption that $R < N_j$, which means that if the retailer operates in perfect competition, so does the supplier.

6. When the retailer is a monopolist $\lim_{R\to 1} \alpha^* = \frac{N_j \rho}{N_j - 1 + \rho}$, i.e. the division of surplus depends on the level of ρ and N_j as expected.

If the retailer achieves truthful revelation, the optimal consumer price is $p_j^C = \beta_r c_j$ and optimal wholesale price is $g_j^C = \beta_j c_j$. The supplier always benefits from the proposed agreement. Under the contract $p_j^{C,*} = \beta_r c_j$ and $g_j^{C,*} = \beta_j c_j$, making the profits of the supplier at least as high as those that follow from the results of Section 3.3. In fact assuming $G' = \sum_{s=1}^{J} (\beta_r c_j)^{\rho/(\rho-1)}$ while $G'' = \sum_{s=1}^{J} (\beta_r \beta_j c_j)^{\rho/(\rho-1)}$. Assuming that $N_j = N$ for all j, all β_j assume the same value β, so that G'' can be rewritten as $G'' = G' \beta^{\rho/(\rho-1)}$.

$$\begin{aligned}\pi_{i,j}^{C,*} &= (\alpha^*\beta_r c_j - c_j)\Big(\frac{Y}{G'}(\beta_r c_j)^{\frac{1}{\rho-1}} - \sum_{s=1}^{N_j-1} q_{s,j}(\beta_r c_j)\Big)\\ &= (\beta_j - 1)c_j\frac{1}{N_j}\frac{Y}{G'}(\beta_r c_j)^{\frac{1}{\rho-1}}\\ &> (\beta_j - 1)c_j\frac{1}{N_j}\frac{Y}{G''}(\beta_r\beta_j c_j)^{\frac{1}{\rho-1}} = \pi_{i,j}^*\end{aligned}$$

For the retailer this is not true, and in order for the contract to be profitable, it needs to add some fixed price to the supplier and consumer to access the service. The differential aggregate welfare, in fact, is higher than the loss for the retailer, so the retailer can charge a fixed fee to suppliers and consumers, F_s and F_c, to allow them to sell and shop through their platform. This is obviously only feasible when the retailer has a high market share, supporting the condition that $R < N_j$. It is easy to see that the loss in profits would be more than compensated by such fees as shown by equations (E.4) to (E.6).

$$\begin{aligned}\pi_{r,j}^{C,*} < \pi_{r,j}^* \quad &\Leftrightarrow (\beta_r - \beta_j)\frac{1}{G'} < (\beta_r - 1)\beta_j^{\frac{\rho}{\rho-1}}\frac{1}{G'\beta^{\rho/(\rho-1)}}\\ &\Leftrightarrow \beta_r - \beta_j < \beta_r - 1\\ &\Leftrightarrow \beta_j > 1\end{aligned}$$

$$\pi_{r,j}^* - \pi_{r,j}^{C,*} = \frac{Y}{G'}(\beta_r c_j)^{\frac{1}{\rho-1}}\frac{1}{R}c_j(\beta_j - 1) \tag{E.4}$$

$$F_s \leq \pi_{i,j}^{C,*} - \pi_{i,j}^* = \frac{Y}{G'}(\beta_r c_j)^{\frac{1}{\rho-1}}\frac{1}{N_j}c_j\frac{(\beta_j - 1)^2}{\beta_j} \tag{E.5}$$

$$F_c \leq U_j^{C,*} - U_j^* = \left(\frac{Y}{G'}\right)^{\frac{1}{\rho}} (\beta_r c_j)^{\frac{1}{(\rho-1)\rho}} \left(1 - \beta_j^{\frac{1}{(1-\rho)}}\right) \tag{E.6}$$

It is trivial to prove that: $\pi_{r,j}^* - \pi_{r,j}^{C,*} \leq F_s + F_c$

E.0.2 Adding Taxation

Assuming that an environmental tax t_j is imposed on the supplier or on the retailer, the effect of these taxes mimic the results of Section 4.2.4 and Section 4.2.5. In fact, once an environmental tax is imposed on the retailer, the profits of the supplier and the retailer when the tax is imposed on the retailer as expressed in equations (E.7) and (E.8) respectively, while their respective profits when the tax is imposed on the supplier are as in equations (E.9) and (E.10)[1].

$$\pi_{i,j}^{C,TR} = \frac{1}{N_j} q_j(\beta_r \frac{c_j}{1-t_j})(\beta_j - 1)c_j \tag{E.7}$$

$$\pi_r^{C,TR} = \frac{1}{R} \sum_{k \in [1,J]/j} (p_k - g_k)\frac{q_k(p_k)}{R} + (\beta_r - \beta_j)c_j \frac{q_j(\beta_r \frac{c_j}{1-t_j})}{R} \tag{E.8}$$

$$\pi_{i,j}^{C,TS} = \frac{1}{N_j} q_j(\beta_r \frac{c_j}{1-t_j})(\beta_j - 1)c_j \tag{E.9}$$

$$\pi_r^{C,TS} = \frac{1}{R} \sum_{k \in [1,J]/j} (p_k - g_k)\frac{q_k(p_k)}{R} + \frac{1}{R}(\beta_r - \beta_j)\frac{c_j}{1-t_j} q_j(\beta_r \frac{c_j}{1-t_j}) \tag{E.10}$$

[1]The assumption is that the contract establishes that payment the supplier is $g_j^C = \alpha\beta_j c_j$ when the tax is imposed on the retailer independently of whether the tax is imposed or not because the optimal strategy for the suppliers is to truthfully communicate its marginal cost independently of the tax. Instead, when the tax is imposed on the suppliers, the optimal communicated marginal cost does include the tax and if of the form $c_j^{C*} = \frac{c_j}{1-t_j}$, therefore, wholesale price becomes $g_j^C = \alpha\beta_j \frac{c_j}{1-t_j}$

The derivatives of these profit functions with respect to the tax yield equations (E.11) and (E.8) when the tax is imposed on the retailer and equations (E.11) and (E.13) when the tax is imposed on the supplier.

$$\frac{\partial \pi_{i,j}^{TR}}{\partial t_j} = \frac{\partial \pi_{i,j}^{TS}}{\partial t_j} = (\beta_j - 1)c_j \frac{1}{N_j}\frac{Y}{G}(\frac{\beta_r c_j}{1-t_j})^{\frac{1}{\rho-1}}\frac{1}{1-t_j}\frac{1}{\rho-1} \tag{E.11}$$

$$\frac{\partial \pi_{r}^{TR}}{\partial t_j} = \frac{(\beta_r - \beta_j)c_j}{1-t_j}\frac{Y}{G}(\frac{\beta_r c_j}{1-t_j})^{\frac{1}{\rho-1}}\frac{1}{\rho-1} - \frac{\rho}{\rho-1}\frac{1}{1-t_j}(\frac{\beta_r c_j}{1-t_j})^{\frac{\rho}{\rho-1}}\frac{\sum_{k=1}^{J}(p_k-g_k)q_k(t_j)}{G} \tag{E.12}$$

$$\frac{\partial \pi_{r}^{TS}}{\partial t_j} = \frac{(\beta_r - \beta_j)c_j}{(1-t_j)^2}\frac{Y}{G}(\frac{\beta_r c_j}{1-t_j})^{\frac{1}{\rho-1}}\frac{\rho}{\rho-1} - \frac{\rho}{\rho-1}\frac{1}{1-t_j}(\frac{\beta_r c_j}{1-t_j})^{\frac{\rho}{\rho-1}}\frac{\sum_{k=1}^{J}(p_k-g_k)q_k(t_j)}{G} \tag{E.13}$$

E.0.3 Adding Environmental Effort

Adding a functional for as in equation (4.2.12) for $t_j(e_{i,j}, e_{r,j})$ that depends on efforts and following the same procedure as outlined in the previous sections, the resulting relative environmental effort functions assume the form outlined in section

$$\frac{(1-e_{i,j})^{b-1}}{(1-e_{r,j})^{a-1}}\Big|_{TR} = \frac{a}{b}\frac{\partial_{e_{i,j}}S(e_{i,j})}{\partial_{e_{r,j}}R(e_{r,j})}\frac{N_j}{R}\Big(\frac{\beta_r-\beta_j}{\beta_j-1} - \frac{\rho}{(\beta_j-1)c_j}(\frac{\beta_r c_j}{1-t_j})^{\rho}(1-\frac{1}{\beta_r})\Big) \tag{E.14}$$

$$\frac{(1-e_{i,j})^{b-1}}{(1-e_{r,j})^{a-1}}\Big|_{TS} = \frac{a}{b}\frac{\partial_{e_{i,j}}S(e_{i,j})}{\partial_{e_{r,j}}R(e_{r,j})}\frac{N_j}{R}\Big(\frac{(\beta_r-\beta_j)\rho}{(\beta_j-1)(1-t_j)} - \frac{\rho}{(\beta_j-1)c_j}(\frac{\beta_r c_j}{1-t_j})^{\rho}(1-\frac{1}{\beta_r})\Big) \tag{E.15}$$

These results are discussed in Section 4.3.

F Consumer Standards When Firms Upgrade Production Technology

When firms upgrade to a cleaner production technology, the variable of interest will be z_j. Assuming that the level of z_j is influenced by the retailers' and suppliers' efforts as in equation (F.1) and Figure .1, the result of the profit maximization problem of the firms over own effort is, similarly to the previous cases expressed in equations (F.2) and (F.3).

$$z_j(e_{r,j}, e_{i,j}) = z - ((1 - e_{r,j})^a + (1 - e_{i,j})^b) \tag{F.1}$$

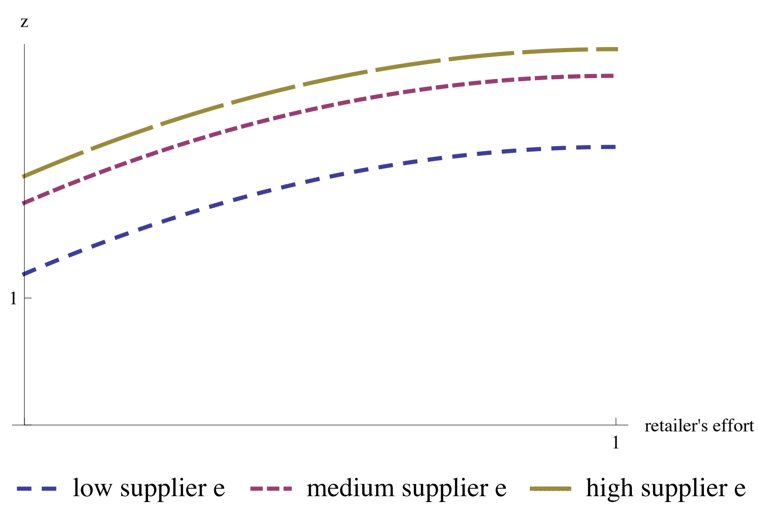


Figure .1*:* Quality Function $z_j(e_{r,j}, e_{i,j})$ *This figure is obtained for values:* $a = b = 2$ *and* $z = 3$*.*

$$\frac{\partial z_j}{\partial e_{r,j}} = \frac{\partial R(e_{r,j})}{\partial e_{r,j}} \Big(\frac{\partial \pi_r(e_{i,j}, e_{r,j})}{\partial z_j} \Big)^{-1} \tag{F.2}$$

$$\frac{\partial z_j}{\partial e_{i,j}} = \frac{\partial S(e_{i,j})}{\partial e_{i,j}} \Big(\frac{\partial \pi_{i,j}(e_{i,j}, e_{r,j})}{\partial z_j}\Big)^{-1} \tag{F.3}$$

Plugging in equations (F.2) and (F.3) the derivative of the profit functions (F.5) and (F.4) and taking the ratio of the two we obtain the relative environmental effort of equation (F.7), which is identical to equation (3.3.17): the relative environmental effort when firms can operate on visibility of the product quality, assuming that the way effort operates on z_j and γ_j is comparable.

$$\frac{\partial \pi_{i,j}}{\partial \Gamma} = (\beta_j - 1)c_j \frac{Y}{G}(\beta_r \beta_j c_j)^{\frac{1}{\rho-1}} z_j^{\frac{\gamma}{1-\rho}-1} \frac{\gamma}{1-\rho} \tag{F.4}$$

$$\frac{\partial \pi_r}{\partial e_{r,j}} = (\beta_k - 1)\beta_j c_j \frac{Y}{G}(\beta_r \beta_j c_j)^{\frac{1}{\rho-1}} z_j^{\frac{\gamma}{1-\rho}-1} \frac{\gamma}{1-\rho} - \tag{F.5}$$

$$+ (\beta_r \beta_j c_j)^{\frac{\rho}{\rho-1}} z_j^{\frac{\gamma}{1-\rho}-1} \frac{\gamma}{1-\rho} \sum_{k=1}^{J} (\beta_r - 1)\beta_k c_K (\frac{Y}{G^2}(\beta_r \beta_k c_k)^{\frac{1}{\rho-1}} z_k^{\frac{\gamma}{1-\rho}}) \tag{F.6}$$

$$\frac{(1-e_{i,j})^{b-1}}{(1-e_{r,j})^{a-1}} = \frac{a}{b} \frac{\partial_{e_{i,j}} S(e_{i,j})}{\partial_{e_{r,j}} R(e_{r,j})} \frac{N_j}{R} \Big(\frac{(\beta_r - 1)\beta_j}{\beta_j - 1} - \frac{(\beta_r \beta_j c_j)^{\rho}}{(\beta_j - 1)c_j} (1 - \frac{1}{\beta_r}) \Big) \tag{F.7}$$

G Proofs of Chapter 3

Proof of the statements in Section 4.2.4 and Section 4.2.4.1. :

The derivatives with respect to t_j of the profits functions of equations (4.2.7) and (4.2.9) are:

$$\frac{\partial \pi_{i,j}^{TR}}{\partial t_j} = (\beta_j - 1)c_j \frac{1}{N_j}\frac{\partial q_j(t_j)}{\partial t_j} = (\beta_j - 1)c_j \frac{1}{N_j} q_j(t_j)\frac{1}{1-t_j}\frac{1}{\rho-1} \tag{G.1}$$

$$\begin{aligned}
\frac{\partial \pi_r^{TR}}{\partial t_j} &= (\beta_r - 1)\beta_j c_j \frac{Y}{G}(\frac{\beta_r\beta_j c_j}{1-t_j})^{\frac{1}{\rho-1}}\frac{1}{\rho-1}\frac{1}{1-t_j} - \sum_{k=1}^{J}\frac{Y}{G^2}(\beta_r - 1)\beta_k c_k \frac{\beta_r\beta_k c_k}{1-t_k}^{\frac{1}{\rho-1}}\frac{\partial G}{\partial t_j} \\
&= \underbrace{\frac{Y}{G}(\frac{\beta_r\beta_j c_j}{1-t_j})^{\frac{1}{\rho-1}}\frac{(\beta_r-1)}{\rho-1}\frac{\beta_j c_j}{1-t_j}}_{\text{negative effect}} - \\
&\quad + \underbrace{\frac{\rho}{\rho-1}\frac{1}{1-t_j}(\frac{\beta_r\beta_j c_j}{1-t_j})^{\frac{\rho}{\rho-1}}\frac{\sum_{k=1}^{J}(p_k-g_k)q_k(t_j)}{G}}_{\text{positive effect}}
\end{aligned}$$

When adding a functional for as in equation (4.2.12) for $t_j(e_{i,j}, e_{r,j})$ that depends on efforts, the derivative of profits with respect to own efforts assume the following form.

$$\begin{aligned}
\frac{\partial \pi_r(e_{i,j}, e_{r,j})^{TR}}{\partial e_{r,j}} &= \frac{\partial \pi_r}{\partial t_j}\frac{\partial t_j(e_{i,j}, e_{r,j})}{\partial e_{r,j}} - \frac{\partial R(e_{r,j})}{\partial e_{r,j}} = 0 \\
\Rightarrow \frac{\partial t_j(e_{i,j}, e_{r,j})}{\partial e_{r,j}} &= \frac{\partial R(e_{r,j})}{\partial e_{r,j}}\Big(\frac{\partial \pi_r(e_{i,j}, e_{r,j})^{TR}}{\partial t_j}\Big)^{-1} \\
\Rightarrow -t_j a(1-e_{r,j})^{a-1} &= \frac{\partial R(e_{r,j})}{\partial e_{r,j}}\Big(\frac{\partial \pi_r(e_{i,j}, e_{r,j})^{TR}}{\partial t_j}\Big)^{-1}
\end{aligned}$$

$$\begin{aligned}
\frac{\partial \pi_{i,j}(e_{i,j}, e_{r,j})^{TR}}{\partial e_{i,j}} &= \frac{\partial \pi_{i,j}}{\partial t_j}\frac{\partial t_j(e_{i,j}, e_{r,j})}{\partial e_{i,j}} - \frac{\partial S(e_{i,j})}{\partial e_{i,j}} = 0 \\
\Rightarrow \frac{\partial t_j(e_{i,j}, e_{r,j})}{\partial e_{i,j}} &= \frac{\partial S(e_{i,j})}{\partial e_{i,j}}\Big(\frac{\partial \pi_{i,j}(e_{i,j}, e_{r,j})^{TR}}{\partial t_j}\Big)^{-1} \\
\Rightarrow -t_j b(1-e_{i,j})^{b-1} &= \frac{\partial S(e_{i,j})}{\partial e_{i,j}}\Big(\frac{\partial \pi_{i,j}(e_{i,j}, e_{r,j})^{TR}}{\partial t_j}\Big)^{-1}
\end{aligned}$$

By substituting equations (4.2.7) and (4.2.9) into the previous functions and taking the ratio we get the relative environmental effort.

$$\frac{-t_j b(1-e_{i,j})^{b-1}}{-t_j a(1-e_{r,j})^{a-1}} = \frac{\partial_{e_{i,j}} S(e_{i,j})}{\partial_{e_{r,j}} R(e_{r,j})} \frac{N_j}{R} \Big(\frac{(\beta_r - 1)\beta_j}{\beta_j - 1} - \frac{\rho \sum_{k=1}^{J} (p_k - g_k) q_k}{(\beta_j - 1) c_j Y} (\frac{\beta_r \beta_j c_j}{1 - t_j})^{\rho} \Big)$$

$$\Rightarrow \frac{(1-e_{i,j})^{b-1}}{(1-e_{r,j})^{a-1}} = \frac{a}{b} \frac{\partial_{e_{i,j}} S(e_{i,j})}{\partial_{e_{r,j}} R(e_{r,j})} \frac{N_j}{R} \Big(\frac{(\beta_r - 1)\beta_j}{\beta_j - 1} - \frac{\rho}{(\beta_j - 1) c_j} (\frac{\beta_r \beta_j c_j}{1 - t_j})^{\rho} (1 - \frac{1}{\beta_r}) \Big)$$

□

Bibliography

Amiti, M., Itskhoki, O., and Konings, J. (2014). Importers, exporters, and exchange rate disconnect. *American Economic Review*, 104(7):1942–78.

Antras, P. (2003). Firms, contracts, and trade structure. *The Quarterly Journal of Economics*, pages 1–29.

Antràs, P. and Chor, D. (2013). Organizing the global value chain. *Econometrica*, 81(6):2127–2204.

Antràs, P., De Gortari, A., and Itskhoki, O. (2017). Globalization, inequality and welfare. *Journal of International Economics*, 108:387–412.

Atkeson, A. and Burstein, A. (2008). Pricing-to-market, trade costs, and international relative prices. *American Economic Review*, 98(5):1998–2031.

Auer, R. A. and Schoenle, R. S. (2016). Market structure and exchange rate pass-through. *Journal of International Economics*, 98:60–77.

Bair, J. and Gereffi, G. (2001). Local clusters in global chains: the causes and consequences of export dynamism in torreon's blue jeans industry. *World development*, 29(11):1885–1903.

Baldwin, R. (2011). Trade and industrialization after globalization's second unbundling: How building and joining a supply chain are different and why it matters. *NBER working paper series*, (17716).

Baldwin, R. and Lopez-Gonzalez, J. (2015). Supply-chain trade: a portrait of global patterns and several testable hypotheses. *The World Economy*, 38(11):1682–1721.

Baldwin, R. and Venables, A. J. (2013). Spiders and snakes: offshoring and agglomeration in the global economy. *Journal of International Economics*, 90(2):245–254.

Baldwin, R. and Venables, A. J. (2015). Trade policy and industrialisation when backward and forward linkages matter. *Research in Economics*, 69(2):123–131.

Banga, R. (2013). Measuring value in global value chains. *Background paper RVC-8. Geneva: UNCTAD.*

Bauman, W., Panzer, J., and Willing, R. (1982). Contestable markets and the theory of industrial structure.

Bolwig, S., Riisgaard, L., Gibbon, P., and Ponte, S. (2013). Challenges of agro-food standards conformity: lessons from east africa and policy implications. *The European Journal of Development Research*, 25(3):408–427.

Boudreau, K. J. and Hagiu, A. (2009). Platform rules: Multi-sided platforms as regulators. *Platforms, markets and innovation*, 1:163–191.

Burstein, A. and Jaimovich, N. (2009). Understanding movements in aggregate and product-level real exchange rates. *unpublished paper, UCLA and Stanford University.*

Cafaggi, F. and Renda, A. (2012). Public and private regulation: mapping the labyrinth. *DQ*, page 16.

Carnovale, M. (2018). On the international transmission of public and private regulation through global value chains and its cost distribution. *Working Paper.*

Chen, Z. and Rey, P. (2012). Loss leading as an exploitative practice. *American Economic Review*, 102(7).

Chenery, H. B. (1975). The structuralist approach to development policy. *The American Economic Review*, 65(2):310–316.

Cherniwchan, J., Copeland, B., and Scott Taylor, M. (2016). Trade and the environment: New methods, measurements, and results. *NBER working paper series.*

Costinot, A., Vogel, J., and Wang, S. (2012). An elementary theory of global supply chains. *Review of Economic Studies*, 80(1):109–144.

Dennis, A. and Shepherd, B. (2011). Trade facilitation and export diversification. *The World Economy*, 34(1):101–122.

Dolan, C. and Humphrey, J. (2000). Governance and trade in fresh vegetables: the impact of uk supermarkets on the african horticulture industry. *Journal of development studies*, 37(2):147–176.

Fafchamps, M. and Hill, R. V. (2008). Price transmission and trader entry in domestic commodity markets. *Economic Development and Cultural Change*, 56(4):729–766.

Feenstra, R. C. (1998). Integration of trade and disintegration of production in the global economy. *The journal of economic perspectives*, pages 31–50.

Fitter, R. and Kaplinsky, R. (2001). Who gains from product rents as the coffee market becomes more differentiated? a value-chain analysis. *IDS bulletin*, 32(3):69–82.

Garcia-Johnson, R. (2000). *Exporting environmentalism: US multinational chemical corporations in Brazil and Mexico*. MIT Press.

Gereffi, G. (1994). The organization of buyer-driven global commodity chains: how us retailers shape overseas production networks. *Contributions in Economics and Economic History*, pages 95–95.

Gereffi, G. (1999a). A commodity chains framework for analyzing global industries. *Institute of Development Studies*.

Gereffi, G. (1999b). International trade and industrial upgrading in the apparel commodity chain. *Journal of international economics*, 48(1):37–70.

Gereffi, G. (2002). Outsourcing and changing patterns of international competition in the apparel commodity chain. In *Responding to Globalization: Societies, Groups and Individuals Conference, Boulder, Colorado*.

Gereffi, G. (2005). The global economy: organization, governance, and development. *The handbook of economic sociology*, 2:160–182.

Gereffi, G., Humphrey, J., and Sturgeon, T. (2005). The governance of global value chains. *Review of international political economy*, 12(1):78–104.

Goldberg, P. K. and Hellerstein, R. (2008). A structural approach to explaining incomplete exchange-rate pass-through and pricing-to-market. *American Economic Review*, 98(2):423–29.

Goldberg, P. K. and Pavcnik, N. (2007). Distributional effects of globalization in developing countries. *Journal of Economic Literature*, 45(1):39–82.

Gopinath, G., Gourinchas, P.-O., Hsieh, C.-T., and Li, N. (2011). International prices, costs, and markup differences. *American Economic Review*, 101(6):2450–86.

Gopinath, G. and Itskhoki, O. (2010). Frequency of price adjustment and pass-through. *The Quarterly Journal of Economics*, 125(2):675–727.

Gopinath, G., Itskhoki, O., and Rigobon, R. (2010). Currency choice and exchange rate pass-through. *American Economic Review*, 100(1):304–36.

Greenhill, B., Mosley, L., and Prakash, A. (2009). Trade-based diffusion of labor rights: A panel study, 1986–2002. *American Political Science Review*, 103(4):669–690.

Grossman, G. M. and Rossi-Hansberg, E. (2008). Trading tasks: A simple theory of offshoring. *American Economic Review*, 98(5):1978–97.

Hellerstein, R. and Villas-Boas, S. B. (2010). Outsourcing and pass-through. *Journal of International Economics*, 81(2):170–183.

Hirschman, A. O. (1958). The strategy of economic development. Technical report.

Hochschild, A. (2006). *Bury the chains: Prophets and rebels in the fight to free an empire's slaves*. Houghton Mifflin Harcourt.

Hoekman, B. and Shepherd, B. (2013). Who profits from trade facilitation initiatives?

Hong, G. H. and Li, N. (2017). Market structure and cost pass-through in retail. *Review of Economics and Statistics*, 99(1):151–166.

Hussain, W. (2012). Stepping up: Ethical consumerism in a world of diminished states. In *Leadership and Global Justice*, pages 157–174. Springer.

Iapadre, P. L. and Pace, G. (2016). Trade intermediaries and the tariff pass-through. *Journal of Industry, Competition and Trade*, 16(4):441–454.

Ivarsson, I. and Alvstam, C. G. (2010). Upgrading in global value-chains: a case study of technology-learning among ikea-suppliers in china and southeast asia. *Journal of Economic Geography*, page lbq009.

Kaplan, D. and Kaplinsky, R. (1999). Trade and industrial policy on an uneven playing field: the case of the deciduous fruit canning industry in south africa. *World Development*, 27(10):1787–1801.

Kaplinsky, R. (2000). Globalisation and unequalisation: What can be learned from value chain analysis? *Journal of development studies*, 37(2):117–146.

Kind, H. J., Koethenbuerger, M., and Schjelderup, G. (2010). Tax responses in platform industries. *Oxford Economic Papers*, 62(4):764–783.

Kraemer, K. L., Linden, G., and Dedrick, J. (2011). Who captures value in the apple ipad and iphone? *Personal Computing Industry Center (PCIC) Working Paper, University of California, Irvine.*

Krugman, P. (1987). The narrow moving band, the dutch disease, and the competitive consequences of mrs. thatcher: Notes on trade in the presence of dynamic scale economies. *Journal of development Economics*, 27(1-2):41–55.

Lambin, E. F., Gibbs, H. K., Heilmayr, R., Carlson, K. M., Fleck, L. C., Garrett, R. D., de Waroux, Y. l. P., McDermott, C. L., McLaughlin, D., Newton, P., et al. (2018). The role of supply-chain initiatives in reducing deforestation. *Nature Climate Change*.

Linden, G., Kraemer, K. L., and Dedrick, J. (2007). Who captures value in a global innovation system? the case of apple's ipod.

Locke, R. M., Qin, F., and Brause, A. (2007). Does monitoring improve labor standards? lessons from nike. *ILR Review*, 61(1):3–31.

Lucas, R. E. (1988). On the mechanics of economic development. *Journal of monetary economics*, 22(1):3–42.

Lucas Jr, R. E. (1993). Making a miracle. *Econometrica: Journal of the Econometric Society*, pages 251–272.

Mayer, F. W. and Milberg, W. (2013). Aid for trade in a world of global value chains: chain power, the distribution of rents and implications for the form of aid. *Capturing the Gains Working Paper*.

Milanovic, B. (2015). Global inequality of opportunity: How much of our income is determined by where we live? *Review of Economics and Statistics*, 97(2):452–460.

Milberg, W. (2004). The changing structure of trade linked to global production systems: what are the policy implications? *International Labour Review*, 143(1-2):45–90.

Milberg, W. and Winkler, D. (2013). *Outsourcing economics: Global value chains in capitalist development*. Cambridge University Press.

Miroudot, S., Lanz, R., and Ragoussis, A. (2009). Trade in intermediate goods and services.

MITCTL (2009). Future-focused supply chains: Supply chain strategies shaped by the future. Technical report, MIT Center for Transportation and Logistic.

Morrison, A., Pietrobelli, C., and Rabellotti, R. (2008). Global value chains and technological capabilities: a framework to study learning and innovation in developing countries. *Oxford development studies*, 36(1):39–58.

Mudambi, R. (2007). Offshoring: economic geography and the multinational firm. *Journal of International Business Studies*, 38(1):206.

Mudambi, R. (2008). Location, control and innovation in knowledge-intensive industries. *Journal of Economic Geography*, 8(5):699–725.

Nakamura, E. (2008). Pass-through in retail and wholesale. *American Economic Review*, 98(2):430–37.

Nakamura, E. and Zerom, D. (2010). Accounting for incomplete pass-through. *The Review of Economic Studies*, 77(3):1192–1230.

Neilson, J. (2008). Global private regulation and value-chain restructuring in indonesian smallholder coffee systems. *World Development*, 36(9):1607–1622.

Neiman, B. (2010). Stickiness, synchronization, and passthrough in intrafirm trade prices. *Journal of Monetary Economics*, 57(3):295–308.

Neiman, B. (2011). A state-dependent model of intermediate goods pricing. *Journal of International Economics*, 85(1):1–13.

Nelson-Horchler, J. (1984). "fighting a boycott: image rebuilding, swiss style". *Industry week*, 220:54–6.

Niesen, M. (2013). How nike solved its sweatshop problem. *Business Insider*.

OECD (2013). Interconnected economies: Benefiting from global value chains. Technical report, Meeting of the OECD Council at Ministerial Level, Paris 29-39 May 2013.

Perkins, R. and Neumayer, E. (2012). Does the 'california effect'operate across borders? trading-and investing-up in automobile emission standards. *Journal of European public policy*, 19(2):217–237.

Ponte, S. and Gibbon, P. (2005). Quality standards, conventions and the governance of global value chains. *Economy and society*, 34(1):1–31.

Poulsen, R. T., Ponte, S., and Lister, J. (2016). Buyer-driven greening? cargo-owners and environmental upgrading in maritime shipping. *Geoforum*, 68:57–68.

Prakash, A. and Potoski, M. (2006). Racing to the bottom? trade, environmental governance, and iso 14001. *American journal of political science*, 50(2):350–364.

Prakash, A. and Potoski, M. (2007). Investing up: Fdi and the cross-country diffusion of iso 14001 management systems. *International Studies Quarterly*, 51(3):723–744.

Rasmussen, P. N. (1956). *Studies in inter-sectoral relations*, volume 15. E. Harck.

Razzaque, M. A. and Keane, J. (2017). Delivering inclusive global value chains. *Future Fragmentation Processes*, page 194.

Rey, P. and Tirole, J. (1986). The logic of vertical restraints. *The American Economic Review*, pages 921–939.

Rey, P. and Vergé, T. (2010). Resale price maintenance and interlocking relationships. *The Journal of Industrial Economics*, 58(4):928–961.

Rochet, J.-C. and Tirole, J. (2003). Platform competition in two-sided markets. *Journal of the european economic association*, 1(4):990–1029.

Rodrik, D. (1998). Has globalization gone too far? *Challenge*, 41(2):81–94.

Rodrik, D. (2006). Goodbye washington consensus, hello washington confusion? a review of the world bank's economic growth in the 1990s: learning from a decade of reform. *Journal of Economic literature*, 44(4):973–987.

Rodrik, D. (2016). Premature deindustrialization. *Journal of Economic Growth*, 21(1):1–33.

Rostow, W. W. (2000). *Development. Critical coneepts in the social sciences, London, New York: Routledge*, pages 105–116.

Ruggie, J. G. (2017). Multinationals as global institution: Power, authority and relative autonomy. *Regulation & Governance*.

Schwartz, D. T. (2017). *Consuming choices: Ethics in a global consumer age*. Rowman & Littlefield.

Selden, M., Ngai, P., and Chan, J. (2013). The politics of global production: Apple, foxconn and china's new working class. *The Asia Pacific Journal Japan Focus*.

Shih, S. (1996). Me-too is not my style: Challenge difficulties, break through bottlenecks, create values. *Taipei: The Acer Foundation*.

Shin, N., Kraemer, K. L., and Dedrick, J. (2012). Value capture in the global electronics industry: Empirical evidence for the "smiling curve" concept. *Industry and Innovation*, 19(2):89–107.

Sriram, S., Manchanda, P., Bravo, M. E., Chu, J., Ma, L., Song, M., Shriver, S., and Subramanian, U. (2015). Platforms: a multiplicity of research opportunities. *Marketing Letters*, 26(2):141–152.

Sturgeon, T. J. (2002). Modular production networks: a new american model of industrial organization. *Industrial and corporate change*, 11(3):451–496.

UNCTAD (2013). *World investment report 2013: Global value chains: Investment and trade for development*. UN.

UNSDG10 (2017). https://sustainabledevelopment.un.org/sdg10.

Vogel, D. (1995). Trading up: Consumer and environmental protection in a global economy.

Vogel, D. (2007). *The market for virtue: The potential and limits of corporate social responsibility*. Brookings Institution Press.

Weinstein, J. and Ambrus, A. (2008). Price dispersion and loss leaders. *Theoretical Economics*, 3(4):525–537.

Williamson, J. (1990). *The Washington consensus*. Washington, DC.

Willis, M. M. and Schor, J. B. (2012). Does changing a light bulb lead to changing the world? political action and the conscious consumer. *The ANNALS of the American Academy of Political and Social Science*, 644(1):160–190.

Xing, Y. and Detert, N. C. (2010). How the iphone widens the united states trade deficit with the people's republic of china.

Young, A. (1991). Learning by doing and the dynamic effects of international trade. *The Quarterly Journal of Economics*, 106(2):369–405.

Ziegler, C. (2007). *Favored flowers: Culture and economy in a global system*. Duke University Press.