Imports and the Structure of Retail Markets[1]

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April 2011

[1]We thank Beverly Lapham, two anonymous referees and participants at various conferences and seminars for helpful comments. Thanks are also due to Rolf Langhammer and Agnès Benassy-Quéré for information about German and French retailing. The authors acknowledge financial support from the Social Sciences and Humanities Research Council of Canada.

Abstract

We construct a model of trade with heterogeneous retailers to examine the effects of trade liberalization on retail market structure, imports and social welfare. We are especially interested in studying the transmission of import prices into consumer prices and the effects of retail market regulation. The paper shows that the changes in import prices may have large effects on consumer prices and import volumes when changes in retail market structure are taken into account, and that restrictions on retailing, as they occur in many countries, may significantly reduce imports and raise consumer prices.

JEL classification: F12, L11

Keywords: international trade, retailing, firm heterogeneity

1 Introduction

The purpose of this paper is to show that the retailing sector plays an important role for our understanding of the impact of trade liberalization. To show this, we concentrate our attention on (i) the effects of trade liberalization on the structure and performance of the domestic retailing sector; (ii) how the structure of retail markets affects the transmission of external shocks, such as a reduction in trade barriers, into domestic consumer prices; and (iii) how retail market regulation affects market structure, imports and consumer prices. To study these issues we build a simple model of international trade with heterogeneous retailers and endogenous markups.

We investigate these issues in a model based on Melitz and Ottaviano (2008) who consider the selection of heterogeneous producers into export markets in a model with endogenous markups. By contrast, in our model it is retailers and thus importers that are heterogeneous. In fact, we neutralize the effects of trade liberalization on the production side of the economy by holding producer prices fixed. This modeling approach allows us to highlight the effects of trade liberalization on changes in retail market structure and on the consequences for consumers and welfare.

Our approach is motivated by several stylized facts. First, the structure of retail markets has changed dramatically in recent decades. Market concentration has increased markedly, driven by the emergence of large national chains operating large establishments.[1] At the same time there has been considerable entry and exit by firms. In fact entry and exit rates have been much higher in retailing than in manufacturing (see Jarmin et al., 2004).[2] Second, this concentration process has had a significant effect on international trade, as large retailers increasingly import consumer goods from low-wage countries

[1] Whereas large retail firms (with at least 100 establishments) represented 18.6% of US retail sales in 1967, their share has increased to 36.9% in 1997, and the average size of these establishments is twice as large as it was 40 years ago. Overall, the retail and manufacturing sectors have similar ratios of single to multi-unit firms but, not surprisingly, multi-unit retailers operate more establishments on average than multi-unit manufacturers. More significantly, the number of establishments operated by multi-unit retailers has increased dramatically between 1977 and 1997 whereas it has decreased in manufacturing during the same period (Jarmin et al., 2005).

[2] According to Foster et al. (2006), productivity gains in retailing have been due almost exclusively to the entry and exit process. Caves (1998) also reports that, although entrants exhibit size heterogeneity at the time of entry, entry and exit are concentrated in the smallest size classes.

like China. Basker and Van (2010), for instance, find that over the period 1997 to 2002 U.S. imports from China and other less-developed countries rose especially quickly in retail sectors with the largest consolidation into chains. Wal-Mart alone accounts for 15% of total US imports from China (Basker and Van, 2008).[3] This phenomenon is not limited to the United States and is taking place in many retail segments, including electronics, computers, cameras, housewares, toys, games, clothing, and footwear.[4]

What makes our model useful is that it allows us to address several important policy issues. First, in many consumer-good industries the benefits consumers may reap from trade liberalization depend crucially on how changes in import prices affect retail market structure, since distribution margins (i.e., retail costs and retailer mark-ups) typically account for 30 to 50 percent of the retail prices of consumer goods (Campa and Goldberg, 2006). Any change in the cost structure and competition of the retail sector thus has a large impact on retail prices and, more generally, on the gains from trade. By linking the transmission of import prices into consumer prices to a structural model of retail markets, we are able to shed new light on this issue. Specifically, we decompose the degree of transmission of import prices into the average domestic retail price into several distinct effects including changes in distribution margins and in the import share.

Second, many countries, including France, Belgium, Italy, Japan, Ireland and the United Kingdom, regulate retail markets, especially by limiting the size of new retail establishments. The Large Scale Retail Store Law in Japan has long been a fixture of distribution system there. It has often been regarded as a substantial non-tariff barrier to trade and has caused significant political conflict between Japan and exporter countries, such as the United States (Miyagiwa, 1993). France only recently abolished the Loi Raffarin,

[3]Basker and Van (2008b) find that between 1997 and 2002 the biggest US retailers had a more than three times higher marginal propensity to import from China than smaller retailers. They argue that the expansion of big retailers accounts for 19% of the growth in US imports of consumer goods from China. On Wal Mart, see also Fishman (2006).

[4]For instance, in 2003, the share of imports in Canada was 55% for clothing, 82% for clothing accessories, 86% for footwear, 100% for audio, video, small electrical appliances, as well as for toys and games (Jacobson, 2006, Table 33). It is precisely in these segments that the market share of large Canadian retailers is the highest: the market shares of the 80 largest retailers in 2004 represented 61% for clothing and accessories, 68% for home electronics, computers and cameras, 57% for housewares, 55% for toys and games and 49% for food. On average, this share was 27% for all the products sold by Canadian retailers (Jacobson, 2006, Table 6).

which also regulated the entry of large retailers, following complaints about the lack of price competition at the retail level and the failure of retailers to pass on falling import prices to consumers (Economist, 2008). In a recent study, the Competition Authority (2009) in Ireland has also blamed retail market regulations for short-changing consumers in the face of declining import prices. In the United States, on the other hand, there some preliminary evidence that especially the relatively poor consumers may have benefitted from the existence of large retailers importing cheap goods from developing countries (Broda and Romalis, 2009). By explicitly accounting for firm heterogeneity in retailing, our model allows us to examine how such regulations affect retail market structure, imports, retail prices and, ultimately, welfare. We show that retail regulations may indeed have strong adverse effects on import volumes, consumer prices and welfare.

The basic mechanism at play in our model depends on economies of scale in importing, specifically fixed costs associated with sourcing goods from abroad. In the presence of such fixed costs, reductions in import prices, whether due to reductions in trade barriers or declining transport and communication costs, benefit large retailers disproportionately, because only these retailers can afford to pay the fixed costs associated with importing. And by making large retailers more competitive, lower import prices tend to squeeze out smaller retailers.

The presence of economies of scale in importing is suggested by the fact that large retailers source a rising share of their goods *directly* from abroad and not through domestic sourcing (either by buying domestically produced goods or products imported through independent intermediaries such as wholesalers or domestic subsidiaries of foreign exporters). A recent survey of Austrian, German and Swiss retailers (Zentes, Hilt and Domma, 2007) indicates that direct importing is indeed mostly done by large retailers, the largest of which operate their own overseas buying offices.[5] It also argues that direct importing is associated with significantly lower variable costs, as it allows retailers to bypass additional layers of intermediaries through buying offices that can directly identify the lowest-cost supplier for specific items. The reason why only big retailers choose the direct import channel is, of course, that it is associated with large fixed costs. These include costs of

[5] Zentes, Hilt and Domma (2007) surveys 86 retailers in Germany, Austria and Switzerland (accounting for about 50% of total retail sales in the region). It shows that direct imports by retailers accounted for 26-29% of total sourcing in 2006. Indirect imports accounted for 35-37% of total sourcing and hence roughly half of total domestic sourcing.

operating buying offices, searching for suppliers, developing products, specifying product standards, training suppliers, and monitoring quality.[6] Evidence from Canadian retailing also suggests that it is the large retailers that carry out the lion's share of direct importing. In NAICS 4481-83 (Clothing, Shoes, Jewelry, Luggage and Leather Goods), for example, large retail establishments, defined as having 50 or more employees, account for 76.3% of direct imports from low-cost Asian countries.[7]

Our paper is linked to the literature in the following way. Retail markets have been investigated by Campbell and Hopenhayn (2005) who show that establishments tend to be larger in larger markets. They also suggest that the dispersion of establishment size is well approximated by a Pareto distribution. The role of international trade on retailers has been analyzed by Basker and Van (2008) who investigate the effects of trade liberalization on competition between a dominant retail chain and small single-market retailers. They find that trade liberalization raises the size of the chain retailer, and that the growth of the chain gives an additional boost to imports. There are two main differences between our paper and that of Basker and Van. First, while Basker and Van endogenize the size of the retail chain, specifically the number of stores it operates, and relate it to the intensive margin of imports, we work with a continuous efficiency distribution of retailers, which also allows us to capture the extensive margin of imports. Second, whereas the efficiency of the retail chain is exogenously given in Basker and Van, the productivity distribution of retailers is endogenous in our model, allowing us to examine trade liberalization affects retail efficiency and thus also retail prices.

Other papers examining the interaction between trade liberalization and retail market structure include Raff and Schmitt (2009) who study the effects of trade liberalization on the volume of imports and social welfare in an oligopoly model, in which retailers may have greater or lesser bargaining power than manufacturers. Eckel (2009) develops a general equilibrium

[6]Buying offices can indeed be quite large. For instance, KarstadtQuelle AG, Germany's biggest apparel and sixth-largest food retailer, used to operate 23 buying offices with a total of 1,100 employees (Zentes, Hilt and Domma, 2007). Another survey (Foreign Trade Association, 2002, p. 9) of 23 European apparel and textile retailers cites, as an example of importing fixed costs, the "sheer number of people involved, from Buying Departments to Sourcing Offices to suppliers...who need to exchange real time information..."

[7]The shares in NAICS sector 4431 (Electronics and Appliances), NAICS sector 4441 (Building Material and Supplies), and NAICS 4511-12 (Sporting Goods, Hobby, Musical Instruments, Books, Periodicals, Music) are 68.2%, 64.1% and 67.6%, respectively. Source: Statistics Canada, Import Register, Catalogue R007009, 2005.

model to examine the effects of trade on retail market structure and especially on product variety and accessibility of retailers. In a setting where retailers are homogeneous in their efficiency but spatially differentiated he shows that trade liberalization may have ambiguous effects on retail markups and social welfare, because it reduces the number of retailers and hence increases the average distance between consumers and stores. By contrast, our paper also provides predictions about how trade liberalization affects the productivity distribution of retailers and the markups of retailers with different productivities.

Other related papers include Francois and Wooton (2010) who show that market structure in distribution becomes increasingly important for trade as tariffs fall; Francois, Manchin and Norberg (2008) who work in an oligopoly framework with representative firms and empirically examine pass-through of tariff and exchange-rate changes into producer and consumer prices; and Richardson (2004) who studies market access to retail distribution. Javorcik, Keller and Tybout (2008) examine the effect of NAFTA on the Mexican soaps, detergents and surfactant industry. They argue that these effects were less due to the reduction in trade costs or to the entry of foreign manufacturers than to 'the fundamental change in relationship' between manufacturers and retailers once Walmex (Wal-Mart of Mexico) entered the market.

Bertrand and Kramarz (2002) discuss the effects of retail market regulation in France, Haskel and Sadun (2009) study the effect of regulation on the productivity of UK retailing, while Schivardi and Viviano (2011) examines the impact of retail market regulations in Italy. These papers, however, are generally not concerned with the effects of regulations on international trade. An exception is Miyagiwa (1993), but his paper does not account for firm heterogeneity in retailing.

The paper continues as follows. In Section 2, we present a simple model of international trade with heterogeneous retailers. The equilibria of the model and comparative static results for marginal changes in trade costs are derived in Section 3. In Section 4 we use the model to study the effect of retail market regulation. In Section 5 we use simulations to assess the impact of trade liberalization on retailer concentration and social welfare both for the case with and without retail market regulation. Section 6 concludes, and the Appendix contains proofs.

2 The Model

In this section, we adapt Melitz and Ottaviano (2008) to develop a simple model of a monopolistically competitive retailing sector with heterogeneous firms that source the goods they distribute both domestically and abroad. Retailers sell only in their domestic market, i.e., their services are non-traded. From the consumer's point of view, the products sold by different retailers are differentiated varieties. This could be because each retailer sells a different bundle of goods, or because the retailers themselves are differentiated.[8] Since the focus of our paper is on firm heterogeneity and an endogenous market structure in retailing, we consider retailer differentiation and keep the production side of the economy very simple by assuming that goods are perfect substitutes and produced by a perfectly competitive manufacturing sector. Retailer differentiation occurs when consumers value different retailer characteristics, such as location or customer services.

There is a continuum of retailers indexed by $i \in \Omega$. All consumers share the same utility function:

$$U = \alpha \int_{i\in\Omega} q_i^c di - \frac{1}{2}\beta \int_{i\in\Omega} (q_i^c)^2 di - \frac{1}{2}\gamma \left(\int_{i\in\Omega} q_i^c di \right)^2 + y, \qquad (1)$$

where q_i^c denotes the quantity per capita bought from retailer i, and y the consumption of the numeraire good. Parameter β describes the degree of substitutability between retailers. If $\beta = 0$, retailers are perfectly substitutable, and consumers care only about their total consumption level, $Q^c = \int_{i\in\Omega} q_i^c di$. The degree of differentiation between retailers increases with β.[9]

Assuming that the demand for the numeraire product is positive, the

[8] In Eckel (2009) retailers are located around a circle and hence spatially differentiated; all retailers sell an identical bundle of differentiated products. In Raff and Schmitt (2011) each retailer sells a different bundle of differentiated goods. In both of these papers, however, retailers are equally productive.

[9] While it may seem unrealistic to assume that consumers visit a continuum of retailers to buy a homogeneous good or bundle of goods, the utility function in (1) may be given a microfoundation in terms of a spatial model of product differentiation. Anderson et al. (1992, ch. 5) demonstrate that the utility function can be reinterpreted as arising from an address model in which each consumer buys from only one retailer, namely the one whose location in characteristics space provides the greatest conditional indirect utility. In particular, the parameter γ may be interpreted as an inverse distance measure between retailers. See Ottaviano and Thisse (1999, Footnote 3).

inverse per-capita demand faced by each retailer i is

$$p_i = \alpha - \beta q_i^c - \gamma Q^c. \tag{2}$$

Denoting by L the number of consumers and by N the mass of active retailers, the market demand faced by retailer i can be expressed as a function of the average retail price $\bar{p}$:

$$q_i(p_i) \equiv L q_i^c = \frac{\alpha L}{\gamma N + \beta} - \frac{L}{\beta} p_i + \frac{\gamma N}{\gamma N + \beta} \frac{L}{\beta} \bar{p}, \tag{3}$$

where

$$\bar{p} = \frac{1}{N} \int_{i \in \Omega^*} p_i di$$

and where Ω^* is the set of active retailers.

Labor, the only factor of production, is inelastically supplied and perfectly mobile between the production and the retailing sectors. Since the numeraire good is produced by a competitive industry under constant returns technology and a unit labor requirement of one, the price of labor in the economy is also equal to one. All costs are therefore expressed in terms of labor requirements.

We assume that retailers first decide wether to enter the market and thus whether to incur the sunk cost F_E. Upon entering, each retailer learns about its specific level of marginal retailing cost c or, equivalently, its productivity $1/c$. We assume that the distribution of c is given by $G(c)$ with support on $[0, c_M]$. Since the entry cost is sunk, only entrants able to cover their marginal cost are active in the market. All remaining entrants are inactive, i.e., do not buy or sell any goods. Assuming that retail productivity follows a Pareto distribution, we let the cumulative distribution function for c be

$$G(c) = \left(\frac{c}{c_M} \right)^k,$$

where $k \geq 1$. When $k = 1$, the distribution is uniform on $[0, c_M]$. As k increases, the distribution shifts toward high marginal costs.[10]

[10] Empirical evidence provided by Foster et al. (2006) indicates not only that there is considerable firm heterogeneity in retailing, but also that an establishment's productivity is fairly stable over time (which validates our assumption of a single productivity draw) and that the productivity distribution among entrants is similar to that of the incumbents (which suggests a stable k).

Once a retailer has entered the market, he has to decide whether to source goods domestically or to import them. Imports involve a per-unit trade cost t and a fixed cost F_I. This fixed cost includes the cost of maintaining buying offices, cooperating with foreign partners to source goods, acquiring information, etc. Production (domestic or foreign) involves no fixed or sunk cost but foreign production is assumed to be cheaper than domestic production. For simplicity, we normalize the marginal cost of foreign producers to zero, and denote the marginal cost of domestic production by $w > 0$.

Hence, active retailers that buy domestically maximize

$$(p_i - c - w)q_i(p_i), \tag{4}$$

whereas active retailers relying on imports maximize

$$(p_i - c - t)q_i(p_i) - F_I. \tag{5}$$

Below we let superscript D indicate domestic sourcing, and I indicate imports.[11]

Taking the mass of active retailers N and average retail price $\bar{p}$ as given when setting their price, it is easy to check that the profit-maximizing markups must satisfy

$$(p_i^D - c - w) = \frac{\beta}{L} q_i(p_i^D) \text{ and } (p_i^I - c - t) = \frac{\beta}{L} q_i(p_i^I).$$

Retailer i's profit-maximizing prices when buying from domestic (foreign) sources are respectively,

$$p_i^D = \frac{1}{2}\left(c + w + \frac{\beta\alpha + \gamma N\bar{p}}{\gamma N + \beta}\right) \text{ and } p_i^I = \frac{1}{2}\left(c + t + \frac{\beta\alpha + \gamma N\bar{p}}{\gamma N + \beta}\right).$$

[11] We may also interpret the good sold by retailers as a composite consumer good q that consists of a domestic good (z), and a good (m) that may either be imported or sourced domestically. Equations (4) and (5) and the rest of the analysis are unchanged if one makes the following assumptions. Let goods z and m be aggregated according to the following CES function $q = (z^\phi + m^\phi)^{\frac{1}{\phi}}$ with $0 < \phi < 1$; z and m are hence imperfect substitutes with an elasticity of substitution equal to $\sigma = 1/(1-\phi)$. Let the marginal cost of z be equal to one. A retailer can source good m in two ways: First, he may buy it domestically at price ω; this is mode D. Second, the retailer may choose direct importing. This strategy involves a fixed cost of importing, F_I, and a variable cost (including the trade cost) $\tau < \omega$. This is mode I. The marginal cost of the composite good q is hence $w \equiv \left(1 + \omega^{\frac{\phi}{\phi-1}}\right)^{\frac{\phi-1}{\phi}}$ in mode D, and $t \equiv \left(1 + \tau^{\frac{\phi}{\phi-1}}\right)^{\frac{\phi-1}{\phi}}$ in mode I.

Defining $c_D \equiv \frac{\beta\alpha+\gamma N\bar{p}}{\gamma N+\beta} - w$, the equilibrium prices and outputs of a retailer with marginal cost c are

$$p^D(c) = w + \frac{1}{2}\left[c_D + c\right]; \tag{6}$$

$$p^I(c) = \frac{1}{2}\left[c_D + w + c + t\right]; \tag{7}$$

$$q^D(c) = \frac{L}{2\beta}\left(c_D - c\right); \tag{8}$$

$$q^I(c) = \frac{L}{2\beta}\left(c_D + w - c - t\right); \tag{9}$$

and profits are

$$\pi^D(c) = \frac{L}{4\beta}\left(c_D - c\right)^2 - F_E; \tag{10}$$

$$\pi^I(c) = \frac{L}{4\beta}\left(c_D + w - c - t\right)^2 - F_E - F_I. \tag{11}$$

Only retailers with marginal costs less than or equal to c_D will remain active, because only they will be able to cover their marginal cost. Active retailers have to select from which source to buy their goods. A retailer is indifferent between domestic sourcing and direct imports if $\pi^D(c) = \pi^I(c)$ This condition defines a critical value of the marginal cost c_I,

$$c_I = c_D + \frac{(w-t)}{2} - \frac{2\beta F_I}{L(w-t)}, \tag{12}$$

such that firms with $c \leq c_I$ prefer imports and firms with $c > c_I$ domestic sourcing. We assume that $c_I \leq c_D$ so that the least efficient active retailers weakly prefer domestic sourcing. This implies that

$$\frac{L}{4\beta}\left(w-t\right)^2 \leq F_I. \tag{13}$$

We also assume that importing is more profitable for the most efficient retailers than domestic sourcing. Thus, at $c = 0$, we require

$$F_I < \frac{L}{4\beta}\left(\left(w-t\right)^2 + 2c_D(w-t)\right). \tag{14}$$

These two assumptions together with the quadratic form of the profit function ensure that the value of c_I solving (12) is unique.

The two cut-off values of the marginal cost, c_D and c_I, define three categories of retailers. Retailers whose marginal cost is sufficiently small ($c \leq c_I$) import; retailers whose marginal costs are in the middle range ($c_I < c \leq c_D$) source goods domestically; and retailers with high marginal costs ($c > c_D$) are not active because they are not able to cover their marginal costs.[12]

Given these cutoffs we can compute the average retail price of active retailers as

$$\overline{p} = \frac{1}{G(c_D)} \left(\int_0^{c_I} p^I(c) dG(c) + \int_{c_I}^{c_D} p^D(c) dG(c) \right), \tag{15}$$

which, with the Pareto distribution, gives

$$\overline{p} = w + \frac{k c_D}{k+1} + \frac{c_D}{2(k+1)} - \frac{(w-t)}{2} \frac{c_I^k}{c_D^k}. \tag{16}$$

Since the marginal active retailer is just indifferent between buying and not buying, we have $q^D(c_D) = 0$ and $p^D(c_D) = w + c_D$. Using this price in (3), the mass of active retailers can be calculated as

$$N = \frac{\beta(\alpha - w - c_D)}{\gamma(w + c_D - \bar{p})}. \tag{17}$$

The mass of active retailers is related to the mass of entrants into the retail market, N_E, by the condition $N = N_E G(c_D)$. In equilibrium the mass of entrants has to be large enough so that the expected profit of a retailer is equal to zero:

$$\int_0^{c_I} \pi^I(c) dG(c) + \int_{c_I}^{c_D} \pi^D(c) dG(c) + \int_{c_D}^{c_M} (-F_E)\, dG(c) = 0. \tag{18}$$

[12] The model could easily be expanded by introducing a fourth category of retailers that import goods indirectly through wholesalers. Wholesalers can be thought of as agents that enable importers to reduce the fixed cost of importing by providing intermediation services to a number of retailers. For instance, if indirect importing through wholesales were associated with a lower fixed cost than direct importing but a higher variable cost, then we could think of indirect importers as lying in terms of their productivity between direct importers and retailers that source goods domestically. The main conclusions of our paper would be unaffected. See also Bernard et al. (2010) who quantify the role of wholesalers and retailers in US trade. Akerman (2010) has a model that explicity considers a role for wholesalers in intermediating trade. See also Blum et al. (2009) for a theoretical and empirical study of trade intermediation.

3 Equilibrium and Comparative Statics

In this section we characterize the equilibrium of the model and examine the comparative statics with regard to changes in the trade cost t. The endogenous variables of the model are $\overline{p}$, c_D, c_I and N. The equilibrium values of these variables are given by equations (12), (16), (17) and (18).

Consider first the zero-profit condition (18). The partial derivative of this condition with respect to c_I is zero since, by definition, $\pi^I(c_I) = \pi^D(c_I)$. Total differentiation of this equation hence yields dc_D/dt. We can then derive dc_I/dt from (12), and the marginal change in $\overline{p}$ from (16).

We obtain the following comparative static results:

Proposition 1 *Trade liberalization (i) forces the least efficient retailers to become inactive (c_D decreases); (ii) induces some retailers to switch to buying imports (c_I rises); and (iii) reduces the average consumer price $\overline{p}$.*

Proof: see Appendix.

The intuition for these effects is as follows. A reduction in the trade cost, ceteris paribus, raises the profits of importers both in absolute terms and relative to those retailers that source their goods domestically. Hence more retailers will turn to imports (c_I rises). To keep the zero-profit condition satisfied ex ante despite the fact that active retailers will ex post earn a larger profit, c_D has to decrease so as to lower the probability of being an active retailer.[13]

Changes in t have a direct effect on $\overline{p}$, as well as indirect effects through changes in the equilibrium values of c_D and c_I:

$$\frac{d\overline{p}}{dt} = \frac{1}{2}\frac{c_I^k}{c_D^k} + \frac{k}{k+1}\frac{dc_D}{dt} + \frac{1}{2(k+1)}\frac{dc_D}{dt} + \frac{(w-t)}{2}\frac{c_I^k}{c_D^k}\left(\frac{k}{c_D}\frac{dc_D}{dt} - \frac{k}{c_I}\frac{dc_I}{dt}\right). \tag{19}$$

The first term is the standard pass-through effect: the share of direct cost savings that an importer passes on to consumers (1/2) times the probability that a good is being imported. This effect is clearly less than one and may be very small if the probability that a good is imported (or, equivalently, the share of imports in consumption) is small. This probability depends in a straightforward way on the trade cost. It also depends on the distribution of

[13] The exit of the least efficient retailers is consistent with empirical evidence provided by Foster et al. (2006).

retailing costs as summarized by parameter k. The last three terms in (19) reflect the fact that trade liberalization (i) changes retailing costs and retail markups as the least efficient retailers become inactive, and (ii) increases the likelihood that a good is being sourced from abroad. Specifically, the second term reflects the fact that a reduction in t lowers the expected unit cost of retailing. The third term indicates that a lower t reduces the markup of domestically sourced goods. The fourth term shows that trade liberalization, by raising the probability of importing, generates cost savings from importing for a bigger share of consumption.

As we just saw, retailers that source their goods from abroad pass only part of the reduction in trade costs on to consumers. Their mark-ups, sales and profits hence rise. Retailers that buy their goods domestically, on the other hand, are forced to cut their mark-ups, which leads to lower sales and profits.[14] These effects can be summarized as follows:

Proposition 2 *Trade liberalization (i) lowers the sales, mark-ups and profits of retailers that source domestically; (ii) raises the sales, mark-ups and profits of retailers that engage in direct imports.*

Proof: see Appendix.

Firms respond to changes in expected profits by entering or exiting the retail sector. Propositions 1 and 2 indicate that trade liberalization indeed induces changes in expected profits. First, since trade liberalization reduces c_D, the likelihood of earning a positive operating profit, $G(c_D)$, falls. Second, the profit earned by an importer rises and, since c_I goes up, so does the probability of being an importer. Third, the profit of a retailer buying goods domestically decreases, but so does the probability of falling into this category.

We can use (17) to derive how the mass of active firms N changes with marginal changes in t, keeping in mind that N is related to the equilibrium mass of entrants N_E via the condition $N = N_E G(c_D)$:

$$\frac{dN}{dt} = \frac{\beta}{\gamma(w + c_D - \overline{p})^2} \left(-(\alpha - \overline{p}) \frac{dc_D}{dt} + (\alpha - w - c_D) \frac{d\overline{p}}{dt} \right). \qquad (20)$$

[14] There is indirect evidence that these effects are important in practice. Basker (2007) argues that Wal-Mart, the world's biggest retailer, has been a very vocal advocate of free trade and runs one of the largest Political Action Committees in the United States.

The first expression in parentheses represents the cost effect: a fall in t reduces the average retail cost and thus implies a higher number of active retailers. The second expression represents the price effect: a decrease in t reduces the average retail price, which drives down the number of active retailers. The sign of $\frac{dN}{dt}$ is therefore generally ambiguous, that is, it depends very much on the characteristics of the retail sector. However, we can prove:

Proposition 3 *Trade liberalization reduces the mass of active retailers if the fixed cost of importing is sufficiently small and the market (as measured by α) is sufficiently big.*

Proof: see Appendix.

It is important to point out that the analysis can also be conducted in the short run when N_E is fixed. In this case, the effect of t on the short-term equilibrium values of $\overline{p}$, c_D and c_I is qualitatively the same as in the long run.[15] The reason is that the selection effect also works in the short run as retailers can very quickly add or drop product lines (i.e. become active or inactive), or change their sourcing strategies.

4 Retail Market Regulation

Our model of retail market structure with heterogeneous firms is precisely what is needed to investigate the effects of retail-market regulations that limit the size of retail establishments as traditionally imposed in France, Belgium, Japan, Italy, the United Kingdom and elsewhere. We will show that such regulations tend to raise average retail prices and to reduce the impact of trade liberalization.

Examples of the kind of retail-market regulations we have in mind include the Loi Royer in France, which came into effect in 1973. This law created regional zoning boards composed of local store owners, politicians and consumer representatives to regulate the establishment of retail stores exceeding 1000 to 1500 m^2, depending on city size, and the enlargement of existing stores (Bertrand and Kramarz, 2002). This law was modified in 1996 by the Loi Raffarin, which extended the authority of these boards to stores with a

[15] In the short run, the equilibrium values of $\overline{p}$, c_D and c_I are given by Equations (16), (12) and (17), where in the latter equation we substitute for N using $N = N_E G(c_D)$. See www.sfu.ca/~schmitt/paper5_shortrun.pdf for a more detailed analysis.

size exceeding 300 m^2 in an attempt to impede entry by hard discounters (Askenazy and Weidenfeld, 2007). The intention of these laws was to protect small retailers from the rapid structural change in the retail industry, but its ultimate effect was to impede the establishment of an efficient retail sector with negative consequences for consumers and employment (see also Bertrand and Kramarz, 2002). In 1975 Belgium enacted legislation to restrict entry of retail establishments exceeding 1000 m^2; these restrictions were relaxed in 2004 with the adoption of the so-called "Ikea Law", named after the Swedish furniture chain that apparently faced difficulties in establishing large stores in Belgium (Askenazy and Weidenfeld, 2007, p. 51). In Italy the regulation of large retail stores was handed to regional authorities in 1998. Schivardi and Viviano (2010) find significantly lower retail employment and productivity but higher retail profits and prices in regions where the entry of large stores was tightly enforced. Haskel and Sadun (2009) study a 1996 retail-market regulation in the U.K., which raised the cost of establishing large stores. They observe a shift by supermarket chains to smaller stores and an accompanying significant negative effect on productivity.

In our model this kind of regulation of the size of retail establishments only affects the very efficient retailers. In effect, such a regulation can be thought of as putting an upper bound on their sales. Suppose the maximum level of sales allowed under the regulation is given by $\hat{q}$. Using $\hat{q}$ in (3), the definition of c_D, and assuming that the marginal retailer that is just constrained in its sales is an importer, we obtain a constrained retailer's markup as

$$c_D + w - \frac{\beta}{L}\hat{q} - c - t, \tag{21}$$

and the profit of a constrained retailer as

$$\hat{\pi}(c) = \left(c_D + w - \frac{\beta}{L}\hat{q} - c - t\right)\hat{q} - F_E - F_I. \tag{22}$$

The critical value of the marginal cost $\hat{c}$ at which a retailer is just constrained is defined by $\hat{q} \equiv q^I(\hat{c})$. Hence

$$\hat{c} = c_D + w - t - \frac{2\beta}{L}\hat{q}. \tag{23}$$

At this level of marginal cost we have $\hat{\pi}(\hat{c}) = \pi^I(\hat{c})$.

Ceteris paribus, a tightening of the constraint raises $\hat{c}$, which implies that the sales constraint hits even less efficient retailers. Of course a change

in $\hat{q}$ also affects the other critical levels of the marginal cost, i.e., c_D and c_I, together with the other endogenous variables, $\overline{p}$ and N_E. The long-term equilibrium values of the endogenous variables when the constraint is binding are given by equations (17), (12) and (23), as well as the new expected-zero-profit condition

$$\int_0^{\hat{c}} \hat{\pi}(c)dG(c) + \int_{\hat{c}}^{c_I} \pi^I(c)dG(c) + \int_{c_I}^{c_D} \pi^D(c)dG(c) + \int_{c_D}^{c_M} (-F_E)\, dG(c) = 0, \tag{24}$$

and the new equation for the average retail price

$$\overline{\hat{p}} = \frac{1}{G(c_D)} \left(\int_0^{\hat{c}} \hat{p}dG(c) + \int_{\hat{c}}^{c_I} p^I(c)dG(c) + \int_{c_I}^{c_D} p^D(c)dG(c) \right), \tag{25}$$

where $\widehat{p}$ is the retail price of a constrained firm.

To derive the comparative static effects of a marginal change in the constraint $\hat{q}$, consider again the zero-profit condition. Since, by definition, $\hat{\pi}(\hat{c}) = \pi^I(\hat{c})$ and $\pi^I(c_I) = \pi^D(c_I)$, the partial derivatives of (24) with respect to $\hat{c}$ and c_I are zero. We therefore directly obtain from (24) the change in c_D for marginal changes in $\hat{q}$. The respective changes in $\hat{c}$ and c_I then follow directly from (23) and (12). The following proposition presents these comparative-static effects:

Proposition 4 *A tightening of the sales constraint $\widehat{q}$: (i) allows less efficient retailers to become active (c_D rises); (ii) reduces the sales of more efficient retailers ($\hat{c}$ rises); and (iii) induces some retailers to source goods from abroad (c_I rises).*

Proof: see Appendix.

Parts (i) and (ii) of the proposition are straightforward. A tighter constraint on the sales of the most efficient retailers raises the residual demand for the unconstrained retailers. This allows the least efficient retailers to remain in business. The surprising result is part (iii), namely that a tighter sales constraint raises retailers' propensity to import. The reason for this is that the higher residual demand allows retailers that before were too inefficient to import to source their goods from abroad. This increase at the extensive margin of imports is, of course, offset by a decrease at the intensive margin: a tighter constraint reduces the import volume of efficient retailers.

To determine the effect of a tighter constraint on the average retail price, we simplify (25) to obtain

$$\overline{\hat{p}} = w + \frac{kc_D}{k+1} + \frac{c_D}{2(k+1)} - \frac{(w-t)}{2}\frac{c_I^k}{c_D^k} + \frac{\hat{c}}{2(1+k)}\frac{\hat{c}^k}{c_D^k}. \tag{26}$$

The first four terms of this equation are the same as in (16). The fifth term is an additional term reflecting the direct effect of the output constraint. It represents the extra expected markup of a constrained firm times the probability that a firm is constrained conditional on its cost being less than c_D.

The change in the average retail price induced by a tighter constraint comes from changes in the cut-off values $\hat{c}$, c_D and c_I. A tighter $\hat{q}$ raises all three cut-off values. This has the following implications. An increase in $\hat{c}$ means that a larger fraction of retailers becomes constrained and thus has higher prices than without the constraint. The increase in c_D also raises $\overline{\hat{p}}$, since at the margin less efficient retailers remain active in the market. The rise in c_I works against the first two effects. Retailers are more likely to source goods from abroad, which is associated with lower variable costs than sourcing goods domestically. One would expect that the first two effects dominate the last one, so that a tightening of the sales constraint raises the average retail price. Formally, we can show that it is indeed the case if either $w-t$ is big and/or F_I is small so that the retailers switching to importing have a relatively high unit retailing cost compared with the rest of the industry and thus have only a small market share.

We formally state these sufficient conditions in the following proposition:

Proposition 5 *A tightening of the sales constraint $\widehat{q}$ raises the average retail price $\overline{\hat{p}}$ if $w-t$ is sufficiently big and/or F_I is sufficiently small.*

Proof: see Appendix.

Retail-market regulation also affects the transmission of changes in import into consumer prices. Since, from (21), $\widehat{p} = c_D + w - (\beta/L)\widehat{q}$, the prices of constrained retailers are not affected at all by the import price, even though we assumed that these retailers do in fact import their goods. The reason for this is that the sales of these firms are below the level at which marginal revenue equals marginal cost, so that small changes in marginal cost have no effect on sales or prices.

In the extreme case where the constraint is so restrictive that it affects all importing firms, trade liberalization has no impact whatsoever on the average retail price even if the import share in the total consumption basket of households is large. Thus, even if retail-market regulation induces a larger mass of retailers to source from abroad, its impact on the most efficient retailers makes the average retail price less sensitive to variations in import prices, at least if the constraint is sufficiently tight (i.e., for $\widehat{q}$ sufficiently close to $q^I(c_I)$). This result can be summarized as follows:

Proposition 6 *Retail-market regulation reduces the pass-through of import prices into the average retail price if the output constraint is sufficiently tight.*

5 Retail Market Concentration and Welfare

In this section we use simulations to illustrate how trade liberalization impacts retail market concentration and social welfare. In the context of the present model, the Herfindahl index, H, is an ideal measure of market concentration. This is because this index takes into account the entire size distribution of the retailing sector and thus both the mass of active retailers as well as the dispersion of retailer size. Indeed, the Herfindahl index, defined as the sum of the squares of all retailers' market shares, can be re-written as (see Waterson, 1984)

$$H = \frac{\sigma_q^2/\bar{q}^2 + 1}{N}, \tag{27}$$

where $\bar{q}$ denotes average sales of active retailers and σ_q^2 is the variance of retail sales. This formulation of H reveals the separate effects on concentration stemming from the mass of retailers and from the impact of retailers' heterogeneity. Thus, in a market with heterogeneous firms, market concentration as measured by the Herfindahl index is negatively related to the mass of active retailers, N, and positively related to the coefficient of variation of retail sales, $\sigma_q/\bar{q}$. Since $0 \leq H \leq 1$, industry concentration is high if a few big retailers account for a large fraction of sales.

Another advantage of H is that it can be used for policy purposes, be it for competition policy or market regulation. For example, the purpose of the retail regulations analyzed in the previous section can be interpreted as controlling retail concentration and thus reaching a lower value of H than market forces alone would generate.

In addition to measuring concentration, we also want to evaluate social welfare. Social welfare in the current model is captured by the following indirect utility function (see Melitz and Ottaviano, 2008):

$$U = I + \frac{1}{2}\left(\gamma + \frac{\beta}{N}\right)^{-1}(\alpha - \bar{p})^2 + \frac{1}{2}\frac{N}{\beta}\sigma_p^2, \tag{28}$$

where σ_p^2 denotes the variance of retail prices. Welfare is obviously decreasing in $\bar{p}$ and increasing in N and σ_p^2.

It is often presumed that a decrease in H is associated with an increase in competition and thus with a smaller social deadweight loss. It is easy to see that such a simple one-to-one relationship between H and U does not necessarily exist in the present model with heterogeneous retailers. Observe in particular that H and U are increasing in σ_q^2 and σ_p^2, respectively. Thus if $d\sigma_q^2/dt$ and $d\sigma_p^2/dt$ are both positive, trade liberalization reduces σ_q^2 and H, and it also reduces σ_p^2 and U, holding fixed the values of the other endogenous variables. In the Appendix, we show that $d\sigma_q^2/dt$ and $d\sigma_p^2/dt$ are indeed both positive, at least when F_I is small. Thus, unless trade liberalization changes the mass of retailers in a way that clearly dominates its effects on the size variation of retailers, it is quite possible that social welfare may increase, even if trade liberalization increases retail market concentration. Clearly, retailer heterogeneity plays a key role in this seemingly contradictory message provided by the Herfindahl index and by social welfare.

Figure 1a illustrates this case. Both welfare (measured by U net of income I) and H monotonically rise with trade liberalization. Welfare increases despite a *decrease* in the number of active retailers, N.[16] This occurs because the average price, $\overline{p}$, falls a lot as the trade barrier comes down due to the different effects captured by (19). Two forces explain why H rises with trade liberalization: the decrease in the number of active retailers and an increase in the degree of heterogeneity among them (i.e., the variance of sales, σ_q^2, rises).

Figure 1b illustrates the more standard case where trade liberalization monotonically raises welfare and lowers the Herfindahl index. Trade liberalization still leads to a decrease in the average retail price but, unlike the previous case, it brings more active retailers. Although H falls with trade

[16] And despite a decrease in σ_p^2. The underlying parameters in the figures are $L = 5$, $F_I = .1$, $w = .25$, $c_M = 5$, $\alpha = 1.75$, $\beta = .9$, $\gamma = .6$, and $k = 1$.

liberalization, its decrease is small as trade liberalization brings more heterogeneous retailers. Clearly, the Herfindahl index is not a reliable indirect indicator of the social welfare impact of trade liberalization.

We use the case illustrated by Figure 1b to show the effects of market regulation restricting the size of the most efficient retailers. Specifically, we assume that the most efficient retailer (with $c = 0$) cannot have a volume of sales greater than 75% of its unconstrained free-trade volume. In the above example, this corresponds to a maximum sales volume allowed by regulation equal to $\widehat{q}^I(c = t = 0) = 1.83$. Of course, such a constraint affects more than just the most efficient retailers but it does so with a smaller relative impact, since less efficient retailers are smaller. Indeed, retailers with a volume of sales less than $\widehat{q}^I(c) = 1.83$ are not affected at all. Table 1 shows the percentage changes with respect to the benchmark case without regulation.

Table 1: Impact of regulation

t	$\overline{\widehat{p}}$	$\overline{\widehat{q}}$	N	H	$U - I$
0	+11%	-16%	+14%	-28%	-14%
.05	+9%	-16%	+13%	-22%	-15%
.1	+8%	-16%	+13%	-19%	-16%
.15	+7%	-15%	+12%	-17%	-17%
.2	+6%	-15%	+11%	-16%	-17%

The regulation has striking effects on both the level of the variables and on the impact of trade liberalization. It significantly increases the number of active retailers and decreases H relative to the benchmark case. In this sense, the introduction of the regulation achieves its goal. Consumers however are hurt since they face higher average prices and lower social welfare than in the benchmark case. Second, regulation also affects the impact of trade liberalization. Even if it still leads to lower prices and a greater average volume of sales, the impact of freer trade is very much muted since the average retail price decreases to a much smaller extent and the average quantity sold by retailers increases much less than without the regulation. Despite its impact on concentration and on the number of retailers, the overall impact of the regulation is a smaller increase in social welfare through trade liberalization than in the absence of such a regulation. Based on this example, it may not be very surprising that French consumers complain that they do not benefit from trade liberalization.

6 Conclusions

Although by focusing on retailers' total volume of sales our model is highly stylized, it has two important messages. The first one is with respect to our understanding of the impacts of trade liberalization. In this regard, this paper shows that these impacts depend very much on the retailing sector and how this sector adjusts to trade liberalization. To show this, we used a simple model where there is no adjustment on the production side, the traditional source of adjustment with respect to trade liberalization, to focus our attention solely on the structure of the retailing industry with heterogeneous retailers. Because buying foreign products involves a fixed cost, only the most efficient retailers source goods from abroad. Trade liberalization then shifts retail sales, mark-ups and profits toward big retailers that engage in direct imports at the expense of small ones that source domestically only. This tends to make retailing more heterogeneous with trade liberalization and may lead to higher retail market concentration, as measured by the Herfindahl Index. The model provides not only clear predictions concerning the sensitivity of retail prices to variations in import prices, but it also tells us the source of these adjustments. Whether adjustments are due to retailers switching the sourcing of their purchases, or because the mass of them is affected, the model suggests that retailer heterogeneity plays an important role in explaining how much consumers benefit from trade liberalization. The importance of the retailing sector for our understanding of trade liberalization can also be seen when analyzing the impact of regulation. Restrictions on the size of retailers can be viewed as neutralizing part of the endogenous response of the retailing sector to external shocks such as trade liberalization. We show that such a restriction impact both the level of key indicators such as average retail prices and social welfare, but also mute the impacts of trade liberalization in a way which is detrimental to consumers.

The second message is that, although stylized, the model is helpful to understand how freer trade may have affected differently some countries. In countries like France, Belgium or Japan, there is a tradition of protecting small local retailers by placing barriers on the expansion and particularly on the size of large retailers, whereas such restrictions typically do exist in countries like the US or Canada. Not surprisingly, restrictions on the volume of sales affect first and foremost the efficient retailers. We show that this allows inefficient retailers to remain active and makes the average retail price higher than it would otherwise be. Interestingly this makes the incentives to

source products from abroad stronger for less efficient retailers, not weaker. We also show that it makes the retail price level less sensitive to changes in the price of imported products. With higher average retail prices and a lower sensitivity of retail prices to foreign shocks, it should not be surprising if French consumers feel that their 'pouvoir d'achat' (purchasing power) has suffered as compared to consumers elsewhere in Europe (Economist, 2008).

The contrast with the United States is striking. Broda and Romalis (2009) show that because poor US households have a different composition of their consumption basket than rich households and because the price index of the poor's consumption basket has declined relative to that of the rich, the impact of the rise in income inequality has been significantly smaller than first feared. It seems fairly clear that this would not have been possible without the instrumental role played by large retailers importing a large volume of products from low-cost Asian countries.

These two examples underline well the significant impact of the retailing sector in a more integrated world. Simply put, in the United States, the large retailers seem to allow poor consumers to keep up with the Joneses whereas in France consumers feel cheated by the retailers and do not perceive much benefit from globalization. Of course much more needs to be done to understand the role and the impact of the retailing sector in today's world. This is left for future research.

7 Appendix

7.1 Proof of Proposition 1

Using the Pareto distribution, (18) can be rewritten as

$$\frac{c_D^{k+2}}{(k+1)(k+2)} + (w-t)c_I^k\left(\frac{w-t}{2} + c_D - \frac{kc_I}{k+1}\right) - \frac{2\beta}{L}\left(c_M^k F_E + F_I c_I^k\right) = 0. \tag{29}$$

Total differentiation of (29) yields

$$\frac{dc_D}{dt} = \frac{c_I^k\left(c_D + w - t - \frac{kc_I}{k+1}\right)}{\frac{c_D^{k+1}}{(k+1)} + (w-t)c_I^k} > 0, \tag{30}$$

since $\frac{c_D^{k+1}}{(k+1)} + (w-t)c_I^k = 2c_D^k(w + c_D - \overline{p}) > 0$ and $w - t + c_D - \frac{kc_I}{k+1} > 0$ due to $w > t$, $c_D > c_I$ and $k < 1 + k$.

From (12) we obtain

$$\frac{dc_I}{dt} = \frac{dc_D}{dt} - \left(\frac{1}{2} + \frac{2\beta F_I}{L(w-t)^2}\right).$$

Substituting for $\frac{dc_D}{dt}$ we have

$$\frac{dc_I}{dt} = \frac{1}{\frac{c_D^{k+1}}{(k+1)} + (w-t)c_I^k}\left[-\left(\frac{1}{2} + \frac{2\beta F_I}{L(w-t)^2}\right)\left(\frac{c_D^{1+k}}{1+k} + (w-t)c_I^k\right) + c_I^k\left(c_D + w - t - \frac{kc_I}{1+k}\right)\right].$$

Using $\frac{2\beta F_I}{L(w-t)^2} = \frac{1}{(w-t)}(c_D - c_I + \frac{w-t}{2})$ (from (12)) in the above expression and simplifying, we get

$$\frac{dc_I}{dt} = \frac{1}{2c_D^k(w + c_D - \overline{p})}\left\{-\frac{c_D^{1+k}}{1+k}\left[1 + \frac{c_D - c_I}{w-t}\right] + \frac{c_I^{1+k}}{1+k}\right\} < 0. \tag{31}$$

Note that $\frac{dc_I}{dt} < 0$ provided $c_D^{1+k}(w - t + c_D - c_I) > (w-t)c_I^{1+k}$ which holds since $w > t$ and $c_D > c_I$.

Using (16), it is easy to check that

$$\frac{d\overline{p}}{dt} = \left(\frac{1+2k}{2+2k}\right)\frac{dc_D}{dt} + \frac{1}{2}\frac{c_I^k}{c_D^k} + \frac{k(w-t)}{2}\frac{c_I^k}{c_D^k}\left[\frac{1}{c_D}\frac{dc_D}{dt} - \frac{1}{c_I}\frac{dc_I}{dt}\right] > 0, \tag{32}$$

since all the terms on the RHS are positive.

7.2 Proof of Proposition 2

Differentiating (8) and (10) with respect to t and using (30), it is easy to check that, for retailers sourcing domestically,

$$\frac{dq^D}{dt} = \frac{L}{2\beta}\frac{dc_D}{dt} > 0 \text{ and } \frac{d\pi^D}{dt} = \frac{L}{2\beta}(c_D - c)\frac{dc_D}{dt} > 0.$$

Next, we show that $\frac{dc_D}{dt} < 1$. Rewriting and manipulating (30),

$$\frac{dc_D}{dt} = \frac{(1+k)(w-t) + c_D + k(c_D - c_I)}{(1+k)(w-t) + \frac{c_D^{1+k}}{c_I^k}}. \tag{33}$$

Thus, $\frac{dc_D}{dt} < 1$ if $c_D + k(c_D - c_I) < \frac{c_D^{1+k}}{c_I^k}$ or if $1 + k(1 - \frac{c_I}{c_D}) < \frac{c_D^k}{c_I^k}$. When $k = 1$, this inequality reduces to $(c_D - c_I)^2 > 0$, and when $k > 1$, the RHS of the above inequality increases faster than the LHS. Since $0 < \frac{dc_D}{dt} < 1$, it is easy to check that, for retailers selling imported goods,

$$\frac{dq^I}{dt} = \frac{L}{2\beta}\left[\frac{dc_D}{dt} - 1\right] < 0 \quad \text{and} \quad \frac{d\pi^I}{dt} = \frac{L}{2\beta}(c_D + w - t - c)\left[\frac{dc_D}{dt} - 1\right] < 0.$$

7.3 Proof of Proposition 3

After substituting for $\overline{p}$ and $\frac{d\overline{p}}{dt}$ in (20), we have

$$sign\left\{\frac{dN}{dt}\right\} = sign\{\left(\frac{w-\alpha}{2+2k}\right)\frac{dc_D}{dt} + \left(\frac{w-t}{2}\right)\frac{c_I^k}{c_D^k}\left(\frac{k(\alpha - w - c_D)}{c_D} - 1\right)\frac{dc_D}{dt} + \frac{(\alpha - w - c_D)}{2}\frac{c_I^k}{c_D^k} - \frac{k(\alpha - w - c_D)}{c_I}\frac{c_I^k}{c_D^k}\left(\frac{w-t}{2}\right)\frac{dc_I}{dt}\}.$$

For F_I equal to its lower bound (see (13)), we have $c_D = c_I$, $\frac{dc_I}{dt} = 0$, and $\frac{dc_D}{dt} = 1$. Therefore,

$$sign\left\{\frac{dN}{dt}\right\} = sign\left\{\frac{w-\alpha}{2+2k} + \frac{w-t}{2}\left(\frac{k(\alpha - w - c_D)}{c_D} - 1\right) + \frac{(\alpha - w - c_D)}{2}\right\}.$$

Further simplification yields:

$$sign\left\{\frac{dN}{dt}\right\} = sign\left\{k(\alpha - w - c_D) - c_D\right\}.$$

Since in equilibrium $dc_D/d\alpha = 0$ from (29), $sign\left\{\frac{dN}{dt}\right\} > 0$ if α is sufficiently big.

7.4 Proof of Proposition 4

Using the Pareto distribution in (24) and totally differentiating the resulting equation gives

$$\frac{dc_D}{d\hat{q}} = -\frac{2\beta\hat{c}^{k+1}}{L\left(\frac{c_D^{k+1}}{(k+1)} + (w-t)c_I^k\right)} < 0. \tag{34}$$

From (23) and (12) we can then compute

$$\frac{d\hat{c}}{d\hat{q}} = \frac{dc_D}{d\hat{q}} - \frac{2\beta}{L} < 0, \tag{35}$$

$$\frac{dc_I}{d\hat{q}} = \frac{dc_D}{d\hat{q}} < 0. \tag{36}$$

7.5 Proof of Proposition 5

Using (35) and (36), the derivative of (26) is

$$\frac{d\bar{\hat{p}}}{d\hat{q}} = \frac{1+2k}{2(1+k)}\frac{dc_D}{d\hat{q}} - \frac{k(w-t)\,(c_D-c_I)}{2}\frac{c_I^{k-1}}{c_D^{k+1}}\frac{dc_D}{d\hat{q}} + \frac{1}{2(1+k)}\frac{\hat{c}^k}{c_D^k}\frac{(c_D(1+k)-k\hat{c})}{c_D}\frac{dc_D}{d\hat{q}} - \frac{\beta}{L}\frac{\hat{c}^k}{c_D^k}.$$

Since $\frac{dc_D}{d\hat{q}} < 0$ and $c_D(1+k) - k\hat{c} > 0$, we have $\frac{d\bar{\hat{p}}}{d\hat{q}} < 0$ if the second term is sufficiently small. Using (12), the second term can be written as:

$$\frac{k(w-t)\,(c_D-c_I)}{2}\frac{c_I^{k-1}}{c_D^{k+1}}\frac{dc_D}{d\hat{q}} = \left(\frac{\beta F_I}{L} - \frac{(w-t)^2}{4}\right)\frac{kc_I^{k-1}}{c_D^{k+1}}\frac{dc_D}{d\hat{q}}. \tag{37}$$

Hence, $\frac{d\bar{\hat{p}}}{d\hat{q}} < 0$ provided that F_I is small and/or $(w-t)$ is big enough.

7.6 Average Sales and Variance of Sales

The average sales volume of active retailers is given by

$$\bar{q} = q(\bar{p}) = \frac{L}{\beta}\left(\frac{c_D}{2(k+1)} + \frac{(w-t)}{2}\frac{c_I^k}{c_D^k}\right), \tag{38}$$

and the derivative with respect to t is

$$\frac{d\bar{q}}{dt} = \frac{L}{2\beta}\left((w-t)\frac{c_I^{k-1}}{c_D^{k+1}}\left(c_D\frac{dc_I}{dt} - c_I\frac{dc_D}{dt}\right) - \frac{c_I^k}{c_D^k} + \frac{1}{k+1}\frac{dc_D}{dt}\right). \tag{39}$$

For $F_I = 0$, we have $c_D = c_I$, $\frac{dc_I}{dt} = 0$, and $\frac{dc_D}{dt} = 1$. Using these values in (39), we obtain

$$\left.\frac{d\bar{q}}{dt}\right|_{F_I=0} = -\frac{L}{2\beta}\left((w-t)\frac{c_I^k}{c_D^{k+1}} + \frac{k}{k+1}\right) < 0.$$

The variance of retail sales is given by

$$\sigma_q^2 = \frac{L^2}{4\beta^2}\left\{\frac{kc_D^2}{(k+2)(k+1)^2} + \left((w-t)^2\left[1-\frac{c_I^k}{c_D^k}\right] + \frac{2k(c_D-c_I)(w-t)}{(k+1)}\right)\frac{c_I^k}{c_D^k}\right\}. \quad (40)$$

Hence

$$\left.\frac{d\sigma_q^2}{dt}\right|_{F_I=0} = (w-t)^2\frac{k}{c_D} + \frac{2kc_D}{(k+2)(k+1)^2} > 0.$$

By continuity we have $d\bar{q}/dt < 0$ and $d\sigma_q^2/dt > 0$ for F_I sufficiently close to zero.

7.7 Variance of Retail Prices

The variance of retail prices is given by:

$$\sigma_p^2 = \frac{1}{4}\left\{\frac{kc_D^2}{(2+k)(1+k)^2} + \left((w-t)^2\left[1-\frac{c_I^k}{c_D^k}\right] + \frac{2\left(c_D-c_I\right)(w-t)}{k+1}\right)\frac{c_I^k}{c_D^k}\right\}. \quad (41)$$

The proof that $d\sigma_p^2/dt > 0$ for F_I sufficiently close to zero is identical to the one for $d\sigma_q^2/dt > 0$. Also note that for $k = 1$, $\sigma_q^2 = (L^2/\beta^2)\sigma_p^2$.

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