Manufacturers and Retailers in the Global Economy

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Abstract

In many consumer-goods industries retailers have become the gatekeepers of product variety. Manufacturers often have to pay so-called slotting allowances to retailers to obtain shelf space. We construct a general-equilibrium model of manufacturing and retailing in a global economy to study the causes and consequences of this development. We then investigate how the equilibrium in the retailing and manufacturing sectors reacts to shocks such as market integration or technological change. We examine how these shocks affect retail and wholesale prices, retailer product assortment, sales, slotting allowances, the allocation of labor between manufacturing and retailing, as well as social welfare. In the process we identify a novel gain from trade consisting of efficiency gains in the vertical distribution chain.
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1 Introduction

This paper develops a simple general equilibrium model with retailers acting as intermediaries between manufacturers and consumers. The paper has two main purposes. The first one is to propose a model capturing key features of the retailing and of the manufacturing industry in order to understand important characteristics of the links between these two sectors and how labor is allocated between them. The second purpose is to investigate how the equilibrium in the retailing and manufacturing sector reacts to shocks such as market integration or technological change. By doing so we are able to shed light on the circumstances under which multi-product retailers increase their assortment, slotting allowances rise, and labor is reallocated from manufacturing to retailing, as well as the welfare impact of these changes. In the process, we identify a novel gain from trade, consisting of efficiency gains in the vertical distribution chain.

When considering intermediation and more specifically retail trade, several stylized facts should be taken into account. The first one is that, over the last 40 years, there has been a fundamental increase in the importance of services in general and of wholesale and retail trade in particular. In the United States, for instance, this shift took place especially strongly from the end of the 1970s and it took place at the expense of manufacturing. Simply put, US employment fell in manufacturing between 1970 and 1990, but rose by 71% in wholesale and retail trade (see Blum, 2008).[1] Today retailing alone is the second largest industry in the US in terms of employment (11% of total employment, a higher share than in manufacturing; US Bureau of Labor Statistics, 2009) and accounts for $3.9 trillion in annual sales (2008).[2]

Second, retailers are typically multi-product firms, often selling a large number of products. In many retail sectors, product assortment has risen over time. According to Quelch and Kenny (1994), the number of consumer-packaged-goods stock-keeping units (SKUs) grew 16% each year between

[1] In 1970, employment in wholesale and retail trade was 22% lower than in manufacturing and it was 31% higher in 1990. The switch in employment remains valid when corrected for the fact that retail and wholesale trade have a greater proportion of part-time jobs than manufacturing.

[2] Not including food services and drinking places (Table 1017: Retail Trade and Food Services, 2010 Statistical Abstract, US Bureau of Census). Note that the US wholesale market represents another $4.5 trillion (2008) in sales split approximately equally between durable and non-durable goods (Table 2012).

1985 and 1992. Grocery retailing is just one example in this respect, but a revealing one. In the US, this sector is dominated by supermarkets (i.e. stores with sales in excess of $2 million annually).[3] In 2008, there were 35,394 supermarkets selling on average 46,852 items. The average number of products sold by a supermarket has also increased significantly over the last 30 years and, with it, the size of supermarkets which has reached an average size of 46,755 square feet in 2008.[4] Interestingly, this has resulted in a steady increase in the ratio of square footage to sales (see Klein and Wright, 2006, Figure 1).

Third, slotting allowances, which are lump-sum payments made by manufacturers to retailers to carry their products, are today an important feature of retailing used in a variety of product lines such as grocery food, tobacco, household supplies, health and beauty aid, textiles, shoes and footwear, and automotive parts (see Sundhir and Rao, 2006; Wilkie et al., 2002). These allowances, which first emerged in the early 1980s, are often explained by the fact that retailers are powerful gatekeepers. They are gatekeepers because they know that many products are new and that many of them fail, and they are powerful because, as large multi-product retailers, they often have little to lose by not selling a particular variety. Importantly, slotting allowances are not used by all retailers in a given segment of the market and they can vary a lot across products.[5] This suggests that they are less the result of retailer characteristics than of the retailer-manufacturer relationship. Our general equilibrium model sheds light on the circumstances under which slotting allowances arise in equilibrium and on the factors determining their size.[6]

Fourth, intermediaries, whether at the wholesale or at the retail level,

[3] In 2002, the sales of supermarkets represented 77% of all US grocery sales for a total sale value of $547.1 billion and they collectively employed 3.2 million workers; see www.fmi.org.

[4] In 2002, the number of supermarkets was 32,981 selling on average 35,000 items and had an average size of 44,000 square feet; see FTC (2003).

[5] The FTC (2003) reports, for instance, that slotting allowances are higher and more prevalent for products like ice cream and salad dressings than they are for bread and hot dogs.

[6] It is also important to make clear that slotting allowances are not associated with high market concentration. Although concentration in retailing has been rising, often faster than at the manufacturing level (see Raff and Schmitt, 2010), it is important to keep market concentration in retailing separate from the use of slotting allowances and from the concept of 'powerful' retailers.

often engage in international trade. Bernard and al. (2010) documents international trade activities at the wholesale and retail level in the US and find that 13% of importing firms are pure retailers responsible for a small proportion of overall US import value but 35% of the value of imports from China. Basker and Van (2008b) find that over the period 1997 to 2002 U.S. imports from China and other less-developed countries rose especially quickly in retail sectors and that Wal-Mart alone accounts for around 15% of total US imports from China (Basker and Van, 2008a). This phenomenon is not limited to the United States and has taken place in many industries, including electronics, computers, cameras, housewares, toys, games, clothing, footwear and groceries.[7] Blum and al. (2009, 2010) find that considerable size difference exists between the foreign exporters and the importers in Chile they deal with. In particular, they find that large multi-product retailers facilitate trade for small exporters (and small exporting countries) because they provide an efficient way of reaching consumers who otherwise would be difficult to find.

We build a general equilibrium model with monopolistic competition among retailers and among manufacturers to examine these stylized facts and to explore the consequences for social welfare. The model has three main components. The first is a standard Krugman (1980) monopolistic-competition manufacturing sector. Each manufacturer produces a single variety of a consumer good with a technology involving fixed and constant marginal costs. Of course, this is a simplification as manufacturers are often multi-product firms; however they typically produce a much smaller number of varieties (see Eckel et al., 2009, for Mexico) than sold by retailers. The second component is the retailing sector through which all differentiated products are distributed. Retailers choose their product assortment and retail prices. These two choices give them power although limited by monopolistic competition. Moreover, each of them understands that distributing more varieties within its own store leads to a cannibalization effect in the sense that the demand for a new product 'eats up' some of the demand for the other varieties sold in the store. We model this cannibalization effect as in Feenstra and Ma (2008), who have developed this idea for multi-product manufacturers.[8]

[7] 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).

[8] See Dhingra (2010) for an alternative model of cannibalization and for showing that

The third component is the critical link between the manufacturers and the retailers, namely the wholesale market. We assume that retailers negotiate wholesale prices with individual manufacturers. Even if this bargaining is efficient in the sense that the wholesale price maximizes the surplus of each retailer-manufacturer pair, there nevertheless exists a fundamental externality stemming from the fact that a retailer-manufacturer pair generally cannot take into account the effect of its decision on other retailer-manufacturer pairs. We show that this externality generates slotting allowances in equilibrium, and we determine the forces that affect them. We also demonstrate that, due to this externality, a greater share of labor is allocated to retailing, product variety is bigger, but sales of each variety and social welfare are smaller than in the second best.

Next we consider the comparative static properties of the model, concentrating on the effects of market integration and technological change in retailing. The model allows us to distinguish between two different types of integration. One is product-market integration, i.e., allowing manufacturers to export their products to more countries and allowing retailers to source differentiated products from different countries. The other is retail-market integration, i.e., allowing retail services to be tradable so that retailers have access to consumers at home and abroad. We find that the shift in employment from manufacturing into retailing and the rise in retailer product assortment are consistent with product-market integration, but that the increase in retailer market concentration and in slotting allowances per variety is better explained by technological change in retailing. We also show that retail-market integration yields greater gains than product-market integration, since it not only leads to lower average production costs and greater product variety, but also reduces the externality-induced inefficiency in the vertical distribution chain.

Our paper is linked to the literature in the following way. There is a growing literature on intermediaries in international trade and in particular on the role of intermediation and its impact on welfare and the gains from trade. It includes Akerman (2010), Antras and Costinot (2010), Blum et al. (2009), Bardhan et al. (2009), and Eckel (2009). The value-added of our paper is to provide a theoretical framework rooted in the standard monopolistic-competition trade model to shed light on the stylized facts discussed above and on the welfare consequences of product- and retail-market

intra-firm cannibalization is empirically relevant at the manufacturing level.

integration.

The role of international trade on retailers and the amplifying role of scale economies and technological change have been analyzed by Basker and Van (2008a) who investigate the effects of trade liberalization on competition between a chain retailer (such as Wal-Mart) 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. Their model is a partial equilibrium model and focuses its attention on big-box retailers such as Wal-Mart. Retail markets have also been investigated by Campbell and Hopenhayn (2005) who show that establishments tend to be larger in larger markets.

Other papers examining the interaction between trade liberalization and retail market structure include Raff and Schmitt (2005, 2006, 2009, 2010). Raff and Schmitt (2005, 2006) examine the effects of trade liberalization on markets where manufacturers have power over retailers, while Raff and Schmitt (2009) study the effects of trade liberalization in a partial equilibrium oligopoly model where retailers have power over manufacturers. It shows that the gains from trade tend to be greater in industries characterized by powerful manufacturers as opposed to powerful retailers, and that trade liberalization in the case of retailer power may even reduce social welfare. Raff and Schmitt (2010) examine the effects of trade liberalization on retail market structure, retail mark-ups and the pass-through of import into consumer prices when retail market structure is endogenous and retailers are heterogenous. Francois and Wooton (2008) show that market structure in distribution becomes increasingly important for trade as tariffs fall; and Richardson (2004) studies market access to retail distribution.

The literature on slotting allowances includes Shaffer (1991) where these allowances as tools controlled by and for the benefit of imperfectly competitive retailers whose purpose is essentially to soften price competition in retailing and shift rents from manufacturers to retailers. Others such as Sullivan (1992) and Klein and Wright (2006) view slotting allowances as a price for scarce shelf space.

The paper continues as follows. In Section 2, we present a simple general equilibrium model with manufacturers and retailers. The equilibrium in a closed economy is presented in Section 3. Comparative static results are presented in Section 4, and Section 5 deals with welfare effects and policy implications. Section 6 concludes, and the Appendix contains proofs.

2 The Model

In this section, we develop a simple model of manufacturing and retailing in general equilibrium. Consumers have Dixit-Stiglitz preferences over differentiated goods that are produced by manufacturers and distributed by monopolistically competitive retailers. Of particular interest is the wholesale market, in which manufacturers and retailers interact. Prices in that market are determined through bargaining. We first develop a model of a single economy and, in a later section, turn to a world economy consisting of identical countries $1, ..., C$.

2.1 Households

The economy has L consumers/workers, each endowed with one unit of labor. Individual preferences are given by the utility function

$$U = y_0 + \rho \ln(Y_d), \qquad \rho < 1, \tag{1}$$

where y_0 denotes the consumption of an outside good, taken as the numeraire, and Y_d is the aggregate individual consumption of the differentiated manufacturers. Letting $y_d(i)$ denote the quantity consumed of variety $i \in \Omega$, we assume that Y_d takes the following CES form:

$$Y_d = \left(\int_{i \in \Omega} y_d(i)^{\frac{\eta-1}{\eta}} di \right)^{\frac{\eta}{\eta-1}}, \tag{2}$$

where $\eta > 1$ is the elasticity of substitution between varieties.

Labor, the only factor of production, is inelastically supplied and perfectly mobile between the production and the retailing sectors. The numeraire good, y_0, is produced by a competitive industry under constant returns to scale and a unit labor requirement of one. The price of labor is hence also equal to one. Maximizing utility subject to the consumer's budget constraint and aggregating individual demands over the L consumers yields the following total demand for variety i:

$$y(i) = \frac{\rho L}{P^{1-\eta}} p(i)^{-\eta}, \tag{3}$$

where $p(i)$ is the retail price of variety i, and P is the CES price index.

2.2 Firms

There are two kinds of firms, manufacturers and retailers. They are identical within each of these two groups of firms. We also assume that retailers are large relative to manufacturers in the sense that each manufacturer produces a single variety and sells that variety exclusively through one retailer, whereas retailers carry many varieties.[9] Each retailer decides what mass of varieties to carry and sets the retail price of each variety. Since the number or retailers and the mass of varieties carried by each retailer are endogenously determined, the total mass of manufacturers is also endogenous. Wholesale prices and transfers between retailers and manufacturers are determined through bargaining; details on the bargaining process are presented in Section 2.3.

Our modelling of retailers as multi-product firms follows Feenstra and Ma (2008) who use this approach to study producers. There are R retailers. The mass of varieties handled by retailer r is $M_r > 0$. We assume that each retailer carries a different set of varieties, and choose the ordering of the products such that retailer 1 carries the first M_1 varieties, retailer 2 the following M_2 varieties, and so on. Hence the total mass of varieties consumed is $\bar{M} \equiv \sum_{r=1}^{R} M_r$, and the aggregate consumption of varieties is

$$Y = \left(\int_0^{M_1} y(i)^{\frac{\eta-1}{\eta}} di + \int_{M_1}^{M_1+M_2} y(i)^{\frac{\eta-1}{\eta}} di + \cdots + \int_{\bar{M}-M_R}^{\bar{M}} y(i)^{\frac{\eta-1}{\eta}} di \right)^{\frac{\eta}{\eta-1}}. \tag{4}$$

Similarly, the CES price index is given by

$$P = \left(\int_0^{M_1} p(i)^{1-\eta} di + \int_{M_1}^{M_1+M_2} p(i)^{1-\eta} di + \cdots + \int_{\bar{M}-M_R}^{\bar{M}} p(i)^{1-\eta} di \right)^{\frac{1}{1-\eta}}. \tag{5}$$

With symmetric manufacturers wholesale prices will be identical across varieties sold by a retailer. The retailer hence sets the same retail price for all varieties in his assortment. Denoting the price retailer r charges for each

[9] The choice between exclusive and non-exclusive dealing contracts has been analyzed in a trade context by Raff and Schmitt (2006, 2009). The current paper has nothing new to add in this dimension, and we therefore do not model it here. It should, however, be noted that exclusive dealing contracts are common in many industries.

of the varieties he sells by p_r, the CES price index (5) simplifies to

$$P = \left(\sum_{r=1}^{R} M_r p_r^{1-\eta} \right)^{\frac{1}{1-\eta}}. \tag{6}$$

Since retailers are big, a change in p_r has an effect on the price index P as long as $M_r > 0$. It is both realistic and useful to assume that retailers take this into account when setting prices. The usefulness of this assumption, as explained further below, comes from the fact that retailers acknowledge that adding a product to their assortment lowers the demand for the other products they carry. This "cannibalization" effect becomes bigger as the retailer adds products, thus putting a limit on product assortment. To see how this works, consider the price elasticity of demand for each variety sold by retailer r. Unlike in the usual CES framework, this elasticity is not constant but rather depends on r's market share, s_r:

$$-\frac{\partial y_r}{\partial p_r} \frac{p_r}{y_r} = \eta(1 - s_r) + s_r, \tag{7}$$

with

$$s_r = \frac{M_r p_r y_r}{\sum_{r=1}^{R} M_r p_r y_r} = \frac{M_r p_r^{1-\eta}}{\sum_{r=1}^{R} M_r p_r^{1-\eta}}. \tag{8}$$

Hence for $M_r > 0$, the price elasticity is decreasing in retailer r's market share.

Retailers are homogeneous in that they all use the same technology; we may therefore drop retailer subscripts whenever this can be done without causing confusion. Retailing involves a fixed cost, k_0, as well as a cost per variety carried, k_1. The former include the usual headquarter costs, including payments for information technology that plays a crucial role in retailing. An important example of the costs that arise per variety carried is the cost of shelf space. This and other costs related to increasing the product assortment are arguably more important than the marginal cost of selling another unit of a given variety. We hence postulate $k_1 > 0$ but normalize the marginal cost of selling a unit of any variety to zero. Hence the labor requirement of a retailer carrying a mass of M varieties is given by

$$l^r = k_0 + k_1 M. \tag{9}$$

Manufacturers are single-product firms; their technology exhibits increasing returns to scale. We follow Krugman (1980) in assuming that production

requires a fixed labor input, α, and a variable labor input, β, both identical across firms. Hence the total labor input required to produce y units of a given variety is given by

$$l^m = \alpha + \beta y, \qquad \alpha, \beta > 0. \tag{10}$$

2.3 The Wholesale Market

The manufacturing and the retailing side of the economy are linked through the wholesale market. There are two forces that determine the wholesale price, w, and any payment or transfer, T, from a retailer to a manufacturer (where T can be negative). First, retailers and manufacturers have to bargain over the wholesale contract. Second, free entry by manufacturers and retailers assures that all rents are dissipated. It is this entry process that ties down the transfers between retailers and manufacturers in equilibrium.

We do not put much structure on the bargaining process, except to assume that (i) each retailer bargains simultaneously and bilaterally with each manufacturer whose product he intends to carry; and that (ii) bargaining is efficient in the sense that the wholesale price is chosen so as to maximize the joint surplus of each retailer-manufacturer pair. The reasoning behind (i) is simply that it would be difficult, even illegal, for a retailer to get together with all his suppliers to jointly fix wholesale prices. The reason for (ii) is that we do not want to introduce any market failures, specifically double marginalization, through an inefficient bargaining procedure. Rather, we want to put the focus on the externalities that arise naturally when a multi-product retailer bargains individually with each manufacturer.

3 Equilibrium of the Closed Economy

In this section we characterize the equilibrium of the closed economy. For given w and T, a retailer chooses the retail price p and the mass of varieties M to maximize:

$$\max_{p,M} \Pi^r = M\,(p - w)\,y - M\,(k_1 + T) - k_0. \tag{11}$$

Substituting for y from (3), the corresponding first-order condition with respect to the retail price reads:

$$p = \left(1 + \frac{1}{(\eta - 1)(1 - s)}\right) w. \tag{12}$$

We observe that the higher is a retailer's market share, s, the higher is his mark-up. The first-order condition with respect to M can be written as:

$$(p - w)\, y - s\,(p - w)\, y = k_1 + T. \tag{13}$$

The left-hand side of (13) gives the marginal benefit of adding a variety. It has two elements: the first term is the additional operating profit generated by this variety. The second term represent the cannibalization effect, that is, the reduction in the demand for the other varieties sold by the retailer times the mark-up on these other varieties. The higher the retailer's market share, the bigger is this cannibalization effect. On the right-hand side of (13) we have the marginal cost of adding a variety, which consists of the direct cost, k_1, and the transfer to the manufacturer producing the additional variety.

A manufacturer's profit, Π^m, is given by

$$\Pi^m = (w - \beta)y + T - \alpha. \tag{14}$$

The total surplus that is generated when a retailer adds the manufacturer's product to his assortment is obtained by solving (13) for T and substituting the resulting expression into (14). This gives:

$$(w - \beta)y + (1 - s)\,(p - w)\, y - k_1 - \alpha. \tag{15}$$

The wholesale price maximizing this surplus is given by the following first-order condition:

$$\frac{\eta y}{\eta - 1} + \left(\frac{\eta w}{\eta - 1} - \beta\right) \frac{dy}{dp}\frac{dp}{dw} = 0, \tag{16}$$

where dy/dp follows from (7) and dp/dw from (12). Solving (16) for the equilibrium wholesale price yields:

$$w = \beta + \frac{s\beta}{\eta(1 - s)}. \tag{17}$$

The wholesale price thus exceeds the manufacturer's marginal cost by a margin that is increasing in the retailer's market share, s. (12) and (17) together imply that there is double marginalization, which means that sales of each variety is inefficiently low. The reason for this distortion is that the bargaining between each manufacturer/retailer pair ignores the fact that the retailer also deals with other manufacturers at the same time. That is, the bargaining creates an externality for the other manufacturers.

In equilibrium free entry by manufacturers implies that $\Pi^m = 0$. As can be seen from (14), the transfer from the retailer to the manufacturer hence has to offset any shortfall between the fixed cost of production, α, and the rents earned by the manufacturer, $(w - \beta)y$; this transfer can, of course, be negative:

$$T = \alpha - (w - \beta)y. \tag{18}$$

This transfer has two parts. In order to be willing to supply output a manufacturer obviously must receive a compensation for his fixed cost, α. The second term is the rent earned by the manufacturer and it flows in the opposite direction as payment from the manufacturer to the retailer carrying his product. This term has a natural interpretation in the context of our model, namely as a slotting allowance. Denoting the slotting allowance by A, we have:

$$A \equiv (w - \beta)y. \tag{19}$$

Slotting allowances thus arise precisely because the wholesale price exceeds the marginal production cost so that manufacturers earn a rent. Naturally, if a manufacturer did not earn any rent, he would be unable to pay a retailer for adding his products to the assortment.

Using (17) and (18) in (13), we can solve for the output of each variety

$$y = (1 - s)\frac{(k_1 + \alpha)(\eta - 1)}{\beta}. \tag{20}$$

To close the model we impose zero-profit conditions on retailers and a labor-market clearing condition on the differentiated goods sector. The retailer zero-profit condition is obtained by setting the profit in (11) equal to zero. This yields an expression for the mass of varieties carried by each retailer as a function of the number of retailers:

$$M = \frac{k_0}{(k_1 + T)}(R - 1). \tag{21}$$

A second equation linking M and R is the labor-market clearing condition. Since in equilibrium a fraction ρ of the labor force is employed in the differentiated goods industry (i.e., in manufacturing and in retailing), this condition can be written as:

$$Rk_0 + RM(k_1 + \alpha) + RMy\beta = \rho L. \tag{22}$$

We can now easily solve for the equilibrium number of retailers,

$$\hat{R} = \frac{1}{\eta}\left(\frac{\eta-1}{2} + \sqrt{\frac{(\eta-1)^2}{4} + \frac{\eta\rho L}{k_0}}\right). \tag{23}$$

and the mass of varieties carried by each retailer:

$$\hat{M} = \left(\frac{\eta}{\eta(1-\hat{s})+\hat{s}}\right)\frac{k_0(1-\hat{s})}{(k_1+\alpha)\,\hat{s}}, \tag{24}$$

where $\hat{s} = 1/\hat{R}$. Concerning retail prices, we can see from (12) and (17) that:

$$\hat{p} = \left(1 + \frac{1}{(\eta-1)(1-\hat{s})}\right)\left(\beta + \frac{\hat{s}\beta}{\eta(1-\hat{s})}\right). \tag{25}$$

The equilibrium value of output per variety can then be obtained by using $\hat{s}$ in (20):

$$\hat{y} = (1-\hat{s})\frac{(k_1+\alpha)\,(\eta-1)}{\beta}. \tag{26}$$

Since the equilibrium transfer between a retailer and manufacturer is $\widehat{T} = \alpha - \widehat{A}$, then, given (19), the equilibrium slotting allowance can be identified as:

$$\hat{A} = \hat{s}\frac{(\eta-1)}{\eta}\,(k_1+\alpha)\,. \tag{27}$$

Using (23) to identify the determinants of $\hat{s}$, we can state:

Proposition 1 *The equilibrium slotting allowance is increasing in the retailer fixed cost (k_0), the cost of adding a variety (k_1), the manufacturer's fixed cost (α), the elasticity of substitution (η), and decreasing in the fraction of income spent on differentiated goods (ρL).*

Proof: see Appendix.

A slotting allowance emerges because a multiproduct retailer's bargaining with each individual manufacturer fails to internalize the effects of this bargaining on other manufacturers. It hence reflects a distortion in the differentiated product sector.

To evaluate the effects of this distortion we compare the equilibrium allocation to the second-best allocation—second best in the sense that we require

the retailers' zero-profit conditions to be satisfied. In the second best, there is no externality, since the wholesale price maximizes not the joint payoff of a manufacturer/retailer pair but rather the entire surplus of each retailer and all the manufacturers selling through him. It is easy to establish that the second-best wholesale price is $w^B = \beta$ and the corresponding transfer that guarantees manufacturers zero profit is $T^B = \alpha$, where the superscript B denotes the second-best allocation. Hence there is no slotting allowance, $A^B = 0$, in the second best. A wholesale price equal to the marginal cost of production implies that there is no double marginalization, and the transfer is set so as to extract the entire profit from each of the manufacturers whose variety the retailer carries.[10]

Given w^B and T^B it is straightforward to establish that $R^B = \hat{R}$ and

$$M^B = \frac{\eta(1-\hat{s})+\hat{s}}{\eta}\hat{M} < \hat{M}, \tag{28}$$

$$y^B = \frac{\hat{y}}{(1-\hat{s})} > \hat{y} \tag{29}$$

$$p^B = \hat{p} - \left(1 + \frac{1}{(\eta-1)(1-\hat{s})}\right)\frac{\hat{s}\beta}{\eta(1-\hat{s})} < \hat{p}. \tag{30}$$

It is apparent from (28) that pairwise bargaining between a multi-product retailer and a manufacturer creates a positive externality for the other manufacturers: each retailer deals with more manufacturers than is socially optimal. The retailer's assortment is thus larger and the sales of each variety smaller than in the second best. These results can be summarized as follows:

Proposition 2 *In a closed economy the product assortment of each retailer is bigger and sales per variety are smaller than in the second best. The total mass of differentiated products in the economy is larger than in the second best.*

This has implications for the allocation of resources between manufacturing and retailing, and for welfare. In particular, it is immediate from (28)

[10] Note that the externality also disappears when all the bargaining power rests with the retailers. This corresponds to the case of *buyer power* examined in a different context by Raff and Schmitt (2009). In other words, buyer power is a means of implementing the second-best allocation. The opposite of buyer power is *seller power*, i.e. a situation in which the manufacturers have all the bargaining power and can make take-it-or-leave-it-offers to the retailers. It is easy to show that the allocation under seller power is identical to the one obtained in the equilibrium of our model.

and (24) that in equilibrium too much labor is devoted to retailing compared to the second best, $\hat{R}(k_0+k_1\hat{M}) > \hat{R}(k_0+k_1M^B)$. Given that a fixed amount of labor is devoted to the differentiated good industry (ρL), this implies that less labor is left over for the production of differentiated products than in the second best.

The fact that in equilibrium retail prices are higher but the mass of varieties is also higher than in the second best makes the welfare comparison non-trivial. Since consumers spend a fixed share of their income on differentiated goods, indirect utility is strictly decreasing in the price index for differentiated goods. The price indices in equilibrium and in the second best are given respectively by $\hat{P} = \hat{p}\left(\hat{R}\hat{M}\right)^{\frac{1}{1-\eta}}$ and $P^B = p^B\left(\hat{R}M^B\right)^{\frac{1}{1-\eta}}$.We can verify, however, that the effect of higher retail prices on the price index dominates the effect of greater product variety so that the following result holds:

Proposition 3 *In a closed economy more labor is allocated to retailing and social welfare is lower than in the second best.*

Proof: see Appendix.

4 Product-Market Integration vs. Technological Change in Retailing

The main question we want to investigate in this section is whether a particular shock, such as product-market integration or technological change in retailing, is able to generate the stylized changes listed in the introduction. By product-market integration we mean a scenario in which goods become tradable across countries but retail services remain non-tradable.[11] Manufacturers are thus able to reach more consumers by exporting goods to foreign markets. From the point of view of retailers, however, the number of households served does not change when product trade is liberalized, simply because there is no cross-border shopping.

[11] We consider the case of retail-market integration in the next Section as it has interesting welfare and policy implications.

4.1 Product-Market Integration

Consider a world consisting of identical countries the number of which is captured by the index $c = 1, ..., C$. We may examine the effects of economic integration by increasing the number of countries in the world economy and studying how this affects the equilibrium. Examining product-market integration requires a few straightforward modifications of the equilibrium conditions. The assortment that each retailer carries now consists of a mass of varieties, $M = CM_c$ where M_c is the number of domestic varieties in country c. However, from the point of view of the manufacturers, the market has expanded as each of them is now able to sell his products to retailers in C countries. If we let y_c denote the quantity sold in a single country and T_c the transfer received from a retailer in a single country, then the effect of allowing manufacturers to access additional countries is to reduce the fixed cost of manufacturing per country, so that the fixed cost of manufacturing is α/C. This simply reflects the fact that manufacturers are able to take advantage of economies of scale in production by spreading their fixed cost over C markets.

This adjustment is also reflected in the labor market clearing condition: only a mass RM/C varieties sold by retailers in a given country are locally produced varieties, but each producer now has an output equal to Cy_c. The new labor market clearing condition of a given economy hence is

$$Rk_0 + RM\left(k_1 + \frac{\alpha}{C}\right) + RMy_c\beta = \rho L. \tag{31}$$

Since product-market integration essentially amounts to a reduction of the fixed cost of production, it neither affects the determination of the wholesale and retail prices, nor does it change the number of retailers. Thus product-market integration has not direct impact on the inefficiency identified in the previous section. What changes is simply output and the number of varieties due to the lower manufacturer fixed cost:

$$\tilde{M} = \left(\frac{\eta}{\eta(1-\widehat{s}) + \widehat{s}}\right)\frac{k_0(1-\widehat{s})}{(k_1 + \alpha/C)\,\widehat{s}}, \tag{32}$$

$$\tilde{y}_c = (1-\widehat{s})\frac{(k_1 + \alpha/C)\,(\eta - 1)}{\beta}. \tag{33}$$

Specifically, product-market integration leads to a market equilibrium in which there is a larger mass of product varieties carried by each retailer

($d\tilde{M}/dC > 0$), a larger total mass of varieties available to consumers (since the number of retailers remains unaffected), and a decrease in the consumption of each variety ($d\tilde{y}_c/dC < 0$). Not surprisingly, these are standard Krugman-type effects. A novel result is the implied impact of product-market integration on the allocation of labor between manufacturing and retailing.

Since resources are being saved in manufacturing, product-market integration implies a shift in resources from manufacturing into the retail sector. This can be seen from (31) where the amount of labor allocated to retailing, $\hat{R}\tilde{M}k_1$, rises, and the fixed labor requirement in manufacturing, $\hat{R}\tilde{M}\alpha/C$, declines; note that the variable labor input in manufacturing, $\hat{R}\tilde{M}\tilde{y}_c\beta$, is independent of C. What makes this reallocation of labor possible is the fact that while the mass of varieties available to consumers rises with market integration, the mass of varieties produced in each country falls so that less labor is required in manufacturing.

It also follows from (27) and (32) that product-market integration has no impact on the total amount of slotting allowances received by each retailer, $\tilde{M}\tilde{A}$, where $\tilde{A}$ is obtained from (27) by replacing α with α/C. However, since each retailer carries more varieties, it is obviously the case that the slotting allowance per variety falls. We may therefore state:

Proposition 4 *Product-market integration (i) has no effect on the number of retailers and total retail sales; (ii) raises the product assortment carried by each retailer and the total mass of varieties available to consumers; (iii) reduces the quantity consumed and the slotting allowance of each variety; and (iv) leads to a reallocation of labor from manufacturing to retailing.*

These results are consistent with several but not all stylized facts listed in the introduction. In particular, they are consistent with the observed shift in employment from manufacturing into retailing, with the observed increase in retailer product assortment, as well as with the increase in the square footage of retail space relative to sales (since sales per variety fall). However, by itself, product-market integration is not able to explain why retailer size has grown, retailer market concentration has risen, or why retailers might enjoy higher slotting allowances per product.

4.2 Technological Change in Retailing

This suggests that other or additional changes may be driving these stylized facts. A likely candidate is technological change in retailing. Arguably, the

widespread adoption of information technology in retailing has significantly raised k_0 relative to k_1 and relative to any retailing marginal cost.

Not surprisingly, an increase in k_0 reduces the equilibrium number of retailers ($d\widehat{R}/dk_0 < 0$), and thus raises retailer market share. This has two effects on the mass of varieties in the second-best benchmark, as can be seen from (32) and (28) after applying $\widehat{s} = 1/\widehat{R}$:

$$\frac{dM^B}{dk_0} = \frac{\widehat{R} - 1}{(k_1 + \alpha)} + \frac{k_0}{(k_1 + \alpha)} \frac{d\widehat{R}}{dk_0}. \tag{34}$$

The first term of (34) is the direct effect which is positive. It implies that an increase in k_0 requires retailers to carry a larger product assortment in order to raise their profit again. The second term is an indirect effect associated with the problem of cannibalization, and it has a negative sign: an increase in market share implied by a rise in k_0 raises the cost of expanding the assortment, because adding a variety reduces demand for the other varieties carried by the retailer. We prove in the Appendix that the direct effect outweighs the indirect effect so that $dM^B/dk_0 > 0$.

In the market equilibrium,

$$\frac{d\hat{M}}{dk_0} = \left(\frac{\eta \widehat{R}}{\eta(\widehat{R} - 1) + 1} \right) \frac{dM^B}{dk_0} - \left(\frac{(\eta - 1)\, \eta M^B}{(\eta(\widehat{R} - 1) + 1)^2} \right) \frac{d\widehat{R}}{dk_0} > 0. \tag{35}$$

Thus, the increase in product variety is unambiguously larger in the market equilibrium than in the second-best benchmark not only because $\eta\widehat{R} > \eta(\widehat{R} - 1) + 1$, but also due to an additional effect as can be seen from the second term of (35). This implies that an increase in k_0 implies fewer and bigger retailers and this market concentration process is more pronounced in the market equilibrium than in our benchmark. Because an increase in the fixed cost of retailing increases both the market share of retailers and the number of varieties each of them carries, the slotting allowance each retailer receives both per variety and in total must increase as well.

An increase in k_0 also raises the mark-up set by retailers. This is the case in our second-best benchmark because the retail sector becomes more concentrated, which lowers the price elasticity of demand. There is an additional effect on the retail price in the market equilibrium: the increase in retail market concentration also leads to a higher wholesale price, which gives

an additional boost to retail prices and reduces the output of each variety. We can summarize these results as follows:

Proposition 5 *An increase in the fixed cost of retailing (i) reduces the number of retailers; (ii) increases the mass of varieties carried by each retailer; (iii) raises retail and wholesale prices; (iv) lowers output and consumption of each variety; and (v) raises the slotting allowance per product and the total allowance received by each retailer..*

Proof: see Appendix.

In other words, to reproduce in our model the stylized facts listed in the introduction we require not just product-market integration but also technological change in retailing, especially if one wants to generate retailers with higher market shares commanding higher slotting allowances for each product they sell.

5 Welfare and Policy Implications

An important point of this paper is to underline the fact that there is a fundamental distortion in the relationship between independent multi-product retailers and manufacturers. In this section, we focus on this point further by showing two additional results: (i) product-trade liberalization leads to greater welfare gains than in the second best, and (ii) unlike in the case of product-market integration, retail-market integration across countries would contribute to decrease this distortion, and therefore would help moving the economy closer to the second-best outcome.

The first result is important because it shows that product integration generates by itself a greater welfare gain with respect to the second best. The second result reinforces the first one and is important for two reasons: retail-market integration brings even greater welfare gains as compared with product-market integration alone but it is also the case that retail-market integration implies a less skewed allocation of labor toward retailing than product-market integration.

The first result is easy to derive. We know that welfare must rise in the case of product-market integration since each retailer carries a greater product assortment and thus consumers gain access to more product variety. This reduces the equilibrium price index, $\hat{P}$. However there is no impact on the

inefficiency arising from the relationship between retailers and manufacturers since retail market structure does not change. In fact, product-market integration has the same *relative* effect on the price index and therefore also on social welfare as in the second best. More precisely,

$$\frac{d\hat{P}}{dC}\frac{C}{\hat{P}} = \frac{dP^B}{dC}\frac{C}{P^B}.$$

But it is still the case that the absolute effect of product-market integration is greater in the market equilibrium than in the second best simply because $\widehat{P} > P^B$.

We now want to show that retail-market integration has even stronger effects in the market equilibrium than in our benchmark because of its impact on market inefficiency. Observe first that retail-market integration, that is, making retail services tradable across countries and thus retailers having access to foreign customers, is equivalent in our model to *full market integration*. Indeed, retail-market integration implies that domestic products are exported by retailers instead of by manufacturers. Without barriers to trade, this is equivalent to the integration of both retail and product markets.

Since fully integrating both types of markets is equivalent to an increase in market size, L, the new labor-market clearing condition (22) for C integrated countries reads:

$$Rk_0 + RM\left(k_1 + \alpha\right) + RMy\beta = \rho CL, \tag{36}$$

where y still denotes the aggregate sales of a variety (equal to the aggregate production) in the C countries, R is the total number of retailers in the C countries, M still denotes each retailer's assortment, and L is the number of consumers in each of the C countries.

Given the new interpretation of some of the variables, it is easy to establish the following result:

Proposition 6 *Retail-market integration: (i) raises the number of retailers and reduces retailer market share; (ii) reduces retail and wholesale prices; (iii) reduces slotting allowances; (iv) raises total production of each variety; (v) increases retailer's product assortment; (vi) increases overall product variety; (vii) raises social welfare; and (viii) moves the equilibrium social welfare closer to the second best.*

Proof: see Appendix.

The intuition for these results is simple. Unlike product-market integration, retail-market integration also allows retailers to spread their fixed costs and their costs of adding an additional variety across the C markets. This raises the total number of retailers in the C countries. As a result, the market share of each retailer, $\hat{s}$, decreases. A lower retail market share reduces the distortion in the wholesale price, moving it closer to marginal cost β, as can be seen from (17). A lower wholesale mark-up is equivalent to a smaller slotting allowance. Another way to see this is to note that a smaller $\hat{s}$ reduces the cannibalization effect, and hence the payment manufacturers have to offer retailers to obtain distribution for their products. The retail price declines due to the reduced wholesale price and because a retailer with a lower market share charges a smaller retail mark-up. Output of each variety obviously has to increase when retail prices fall.

To understand the effect of retail-market integration on retailer product assortment it is useful to rewrite (28) as:

$$\hat{M} = \left(\frac{\eta}{\eta(1-\hat{s}) + \hat{s}} \right) M^B, \tag{37}$$

where the first term comes from the market distortion. The reduction in the cannibalization effect associated with a smaller $\hat{s}$ increases directly M^B. However, the distortion also becomes smaller which decreases the first term. As shown in the Appendix, the effect on M^B is dominant, so that retailer product assortment rises with retail-market integration. Social welfare must unambiguously rise, since retail prices are falling and overall product variety in the economy is increasing. Finally, as the distortion in the wholesale market shrinks, equilibrium welfare approaches the second-best level.

The last point is to see how the allocation of labor between manufacturing and retailing adjusts to retail market integration. To analyze this case it is useful to divide both sides of (36) by C to obtain the allocation of labor within a given country. Since R rises less than proportionately with C, as can be seen from (23), the fixed labor requirement in retailing, Rk_0/C, falls. The labor that is then released has to go into the production and distribution of additional varieties and into an increase in the output per variety, y. Hence labor is clearly shifting from retailing into manufacturing. In other words, retail-market integration leads to a more 'balanced' allocation of labor between manufacturing and retailing as compared to product-market integration.

6 Conclusions

Significant changes have occurred in retailing over the last forty years. These changes make an analysis of the relationship between retailers and manufacturers interesting and non-trivial. A better understanding of these changes is also important because of their consequences for the impact of freer trade whether it is at the product or at the retail service level.

In this paper we propose to analyze this relationship within the context of a standard monopolistic competition approach. In addition to introducing a link through the wholesale market between retailers and manufacturers, the main new characteristics of the model are that retailers are multi-product firms and that each of them understands that selling one more variety is not without impact on the demand for the other varieties he sells. When such retailers enter in a competitive relationship with manufacturers and bargain bilaterally with each manufacturer whose product they consider selling, then an externality necessarily arises. It is because, in such an environment, the bargaining pair is unable to take into account the effect of their decision on other manufacturers. This externality is thus directly linked to the fact that retailers are multi-product firms. It does not depend, however, on our simple modeling of manufacturers producing a single good. The same externality would persist with multi-product manufacturers as long as one manufacturer is not the only provider of the products sold by a retailer and thus as long as each manufacturer produces a smaller mass of varieties than sold by a retailer. It is the presence of this externality that allows us to conclude that, with respect to the second-best outcome, retailers sell too many products in too small a quantity, at too high a price, and that too much resources are devoted to retailing as compared to manufacturing. It is also this externality that explains why slotting allowances emerge in equilibrium.

This approach allows us to examine the causes and consequences of the increase in retailer's market share, the trend toward big-box retailing and a greater emphasis on slotting allowances. We discovered that it is less due to trade liberalization at the product or at the retailing service level than to technological changes in retailing, such as the increased use of information and communication technology that has raised the fixed cost of retailing. A higher retailer fixed cost reduces the equilibrium number or retailers, raises the mass of manufacturers, makes retailers bigger, and leads to a rise in the slotting allowance per product. It should be emphasized that the fact that retail concentration does not rise as a result of product-market integration

is in part due to the structure of the model particularly the fact that firms are identical. In a related paper that places much more emphasis on the retailing sector and much less on the links with manufacturers, Raff and Schmitt (2010) shows that product-market integration may indeed lead to higher concentration at the retail level when there is heterogeneity among retailers.

In the present model, free product trade leaves the number of retailers in a country unchanged but raises the product assortment each retailer carries. The economic process that is at work here is that the integration of markets allows manufacturers to realize economies of scale by selling to more customers; the mass of manufacturers in each country falls. Still consumers gain access to more varieties than before as they now turn to imported varieties. What makes this possible is that labor that is saved in the manufacturing sector is reallocated to retailing, allowing each retailer to carry more varieties, including a larger share of imported varieties. In the case of retail market integration there is an additional positive effect on welfare, since trade lowers the per-variety slotting allowance that a manufacturer must pay a retailer to induce him to carry its product. It leads to a less skewed allocation of resources between retailing and manufacturing than with free product trade alone.

In this paper we have assumed that retailers and manufacturers are independent and that manufacturers must bargain with retailers in order to have their product made available to consumers. Vertical integration could easily be examined in our model as well. In fact, to the extent that vertical integration eliminates the externalities between each retailer and the manufacturers it deals with the market outcome would be identical to the second best derived in Section 3. This shows one more time that the central point of this paper is linked to the externality that manufacturers and multi-product retailers generate when they must bargain. This externality is an important element to understand both the gains from trade generated by product- and by retail-market integration and the allocation of labor between retailing and manufacturing.

7 Appendix

7.1 Proof of Proposition 1

The changes in A caused by changes in k_0, k_1, α and ρL are straightforward. To determine the comparative statics with respect to η rewrite A as

$$\begin{aligned}\widehat{A} &= \frac{(\eta-1)(k_1+\alpha)}{\left(\frac{\eta-1}{2}+\sqrt{\frac{(\eta-1)^2}{4}+\frac{\eta\rho L}{k_0}}\right)} \\ &= \frac{(\eta-1)(k_1+\alpha)}{D}\end{aligned}$$

Thus

$$\frac{\partial\widehat{A}}{\partial\eta}=\frac{1}{D^2}\left[(k_1+\alpha)D-(\eta-1)(k_1+\alpha)\left\{\frac{1}{2}+\frac{1}{2}\left(\frac{(\eta-1)^2}{4}+\frac{\eta\rho L}{k_0}\right)^{-\frac{1}{2}}\left(\frac{(\eta-1)}{2}+\frac{\rho L}{k_0}\right)\right\}\right].$$

$$\begin{aligned}sign\frac{\partial\widehat{A}}{\partial\eta} &= sign\left[D-\frac{\eta-1}{2}\left\{1+\frac{\left(\frac{\eta-1}{2}+\frac{\rho L}{k_0}\right)}{\sqrt{\frac{(\eta-1)^2}{4}+\frac{\eta\rho L}{k_0}}}\right\}\right] \\ &= sign\left[\sqrt{\frac{(\eta-1)^2}{4}+\frac{\eta\rho L}{k_0}}-\frac{\eta-1}{2}\left(\frac{\left(\frac{\eta-1}{2}+\frac{\rho L}{k_0}\right)}{\sqrt{\frac{(\eta-1)^2}{4}+\frac{\eta\rho L}{k_0}}}\right)\right] \\ &= sign\frac{\rho L}{k_0}\left(\frac{\eta+1}{2}\right)>0.\end{aligned}$$

7.2 Proof of Proposition 3

Since the number of retailers is the same in equilibrium and in the second best, the respective price indices can be written as

$$\hat{P}=\hat{p}\left(\hat{R}\hat{M}\right)^{\frac{1}{1-\eta}} \quad \text{and} \quad P^B=p^B\left(\hat{R}M^B\right)^{\frac{1}{1-\eta}}. \tag{38}$$

We hence have

$$\hat{P}-P^B = \hat{R}^{\frac{1}{1-\eta}}\left[\hat{p}\hat{M}^{\frac{1}{1-\eta}}-p^BM^{B\frac{1}{1-\eta}}\right] \tag{39}$$

$$= p^B\left(\hat{R}M^B\right)^{\frac{1}{1-\eta}}\left[\frac{1}{(1-\hat{s})}\left(\frac{\eta}{\eta(1-\hat{s})+\hat{s}}\right)^{\frac{\eta}{1-\eta}}-1\right]. \tag{40}$$

$\hat{P} - P^B > 0$ provided that the expression in brackets is positive. This is the case if $f(\hat{s}, \eta) \equiv \hat{s} - \eta (1 - \hat{s}) \left[(1 - \hat{s})^{-\frac{1}{\eta}} - 1 \right] > 0$ for $\eta > 1$ and $\hat{s} \in (0, 1)$. Note that $f(0, \eta) = 0$. The proof proceeds by showing that $f(\hat{s}, \eta)$ reaches a minimum in $\hat{s}$ at $\hat{s} = 0$:

$$\frac{\partial f(\hat{s}, \eta)}{\partial \hat{s}} = 1 + \eta \left[(1 - \hat{s})^{-\frac{1}{\eta}} - 1 \right] - (1 - \hat{s})^{-\frac{1}{\eta}} \stackrel{!}{=} 0 \qquad \text{at } \hat{s} = 0,$$

and

$$\frac{\partial^2 f(\hat{s}, \eta)}{\partial \hat{s}^2} = \left(1 - \frac{1}{\eta} \right) (1 - \hat{s})^{-\frac{1+\eta}{\eta}} > 0 \qquad \forall \hat{s} \in [0, 1) \text{ and } \eta > 1.$$

7.3 Proof of Proposition 5

First note that

$$\frac{d\widehat{R}}{dk_0} = - \left(\frac{(\eta - 1)^2}{4} + \frac{\eta \rho L}{k_0} \right)^{-\frac{1}{2}} \frac{\rho L}{2k_0^2} < 0. \tag{41}$$

Using this we can rewrite (34) as follows:

$$\frac{dM^B}{dk_0} = \frac{1}{(k_1 + \alpha)} \left(\widehat{R} - 1 - \frac{\rho L}{k_0} \frac{1}{\eta \left(2\widehat{R} - 1 \right) + 1} \right). \tag{42}$$

Hence $dM^B / dk_0 > 0$ if and only if

$$\left(\widehat{R} - 1 \right) \left[\eta \left(2\widehat{R} - 1 \right) + 1 \right] - \frac{\rho L}{k_0} > 0. \tag{43}$$

Rewriting the labor-market clearing condition as

$$\eta \widehat{R}^2 - (\eta - 1) \widehat{R} = \frac{\rho L}{k_0}, \tag{44}$$

and using (44) in (43) we obtain

$$R^2 - 2R + 1 > \frac{1}{\eta},$$

which holds as both R and η are greater than one.

7.4 Proof of Proposition 6

Given an increase in L: (i) The increase in $\hat{R}$ (and decrease in $\hat{s}$) follows immediately from (23). (ii) The decrease in $\hat{s}$ reduces $\hat{p}$ and $\hat{w}$, as can be seen in (25) and (17), respectively. (iii) The fall in $\hat{A}$ follows from (27), and (iv) the rise in $\hat{y}$ from (26). (v) The effect on $\hat{M}$ is given by:

$$\begin{aligned}\frac{d\hat{M}}{d\hat{s}} &= \frac{k_0(1-\hat{s})}{(k_1+\alpha)\,\hat{s}}\frac{\eta(\eta-1)}{(\eta(1-\hat{s})+\hat{s})^2} - \frac{k_0}{(k_1+\alpha)\,\hat{s}^2}\frac{\eta}{\eta(1-\hat{s})+\hat{s}} \\ &= -\frac{k_0}{(k_1+\alpha)\,\hat{s}^2}\frac{\eta}{(\eta(1-\hat{s})+\hat{s})^2}\left[(1-s)(\eta(1-s)+s)+s\right] < 0.\end{aligned}$$

(vi) Overall product variety, $\hat{R}\hat{M}$, rises, since both components increase. (vii) The rise in social welfare follows directly from the fall in the price index due to the decrease in retail prices and the increase in $\hat{R}\hat{M}$. (viii) From (40), $\left(\hat{P} - P^B\right)$ is proportional to

$$Z(\hat{s}) \equiv \frac{1}{(1-\hat{s})}\left(\frac{\eta}{\eta(1-\hat{s})+\hat{s}}\right)^{\frac{\eta}{1-\eta}}.$$

We have

$$\frac{dZ(\hat{s})}{d\hat{s}} \equiv \frac{1}{(1-\hat{s})}\left(\frac{\eta}{\eta(1-\hat{s})+\hat{s}}\right)^{\frac{\eta}{1-\eta}}\left[\frac{\eta(1-\hat{s})}{\eta(1-\hat{s})+\hat{s}} + \frac{1}{1-\widehat{s}}\right] > 0,$$

so that a fall in $\hat{s}$ reduces $Z(\hat{s})$.

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