Tariffs Passing Through Retailers*

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Abstract

It is common to model the effects of trade policy in the absence of an intermediary retailer. If the prices set by a retailer do not depend on any demand cross-effects, then this retailer absence is not an issue – insights from Amir, Jin, and Pech (2010 working) show that would indicate that this is true for multi-product monopolies. However, these demand cross-effects may matter if one models retailers in a duopoly setting as retailers are selling a "basket of goods" in which the variance of prices may matter. We derive a simple "linear-city" model in which two retailers compete over a mass of consumers with quadratic utility à la Melitz and Ottaviano (2008 ReStud). We then investigate the effect of an increase in the cost of one variety (via increased trade restrictions) on the price of remaining varieties (domestic varieties). This is important because if, for instance, the United States increases a tariff on Chinese products and Walmart responds by also increasing the price of domestic varieties, then the gains from a tariff could be dampened and the losses exacerbated.

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1 Introduction

Recent empirical evidence suggests that wholesalers and retailers play an active role in international trade (Blum et al. 2010, Bernard et al. 2010). This evidence is noteworthy because most of the theoretical analysis on the gains from international trade focus on adjustments in the manufacturing sector and assume that lower manufacturing prices are perfectly passed on to consumers. But with an extra layer of firms between manufacturers and consumers, lower manufacturing prices do not necessarily translate into lower consumer prices, in particular if the wholesale or retail sector is only imperfectly competitive. In this case, the issue of pass-through of price changes from global markets to local consumers becomes important.

Consequently, the role of local retail markets for the pass-through has been subject to prior inquiries. Raff and Schmitt (2009) analyze how changes in the market structure of local retail markets can affect the pass-through of reductions in trade costs in a monopolistically competitive retail market. They find that selection effects in the retail markets can have similar effects for prices and welfare as selection effects in manufacturing markets. In an empirical study, Hellerstein (2009) analyzes the pass-through of exchange rate changes in the beer market and finds that a significant portion of the costs of exchange rate changes are borne by local retailers. Berner and Birg (2012) provide evidence that the pass-through in the retail sector depends on the type of outlet and may be different for consumers with different levels of income.

This paper addresses the role of retailers for the effect of a tariff on domestic producers. Conventional wisdom suggests that domestic manufacturers benefit from a tariff on the products of foreign competitors. The intuition is that domestic consumer will shift their expenditures towards domestic products because their relative price has fallen. As a consequence, demand for domestic products increases, and this will typically boost profits of domestic producers.

Our paper emphasizes that there is a countervailing effect if one takes into account how retailers adjust their mark-ups in response to a tariff. Retail markets are not perfectly competitive, and retailers adjust their mark-ups when their procurement costs change. As multi-product firms they internalize demand linkages across products (commonly referred to as cannibalization effect). In particular, retailers shift their mark-ups away from products that have become relatively more expensive, and raise their mark-ups on products that have become relatively less expensive. These adjustments in the retail mark-ups counteract the initial impact of the tariff on domestic consumer prices. In this paper, we analyze the determinants of the size of this effect, and how this effect changes the implications of a tariff for domestic producers.

For our analysis, we assume that retailers are horizontally differentiated. In our design, there are two retailers at the two end points of a line that compete for the costumers who live in the space between these two retailers. We assume that the consumers are uniformly distributed along the line, and that they make a single trip to one of the two retailers to run their errands (one stop shopping). When deciding where to shop, consumers do not only look at the distance to the nearest retail outlet, but also take the prices at these outlets into account. This implies that retail mark-ups do not only affect the intensive margin of how much consumers buy, but also the extensive margin of how many consumers actually visit a retail outlet, and we assume that retailers take these changes in the extensive margin into account when making their mark-up decisions.

The existence of an extensive margin is important in our context. The point of this paper is that changes in the profit margins of one good have an impact on the profit margins of another good within the assortment of the retailer. In another context, Amir et al. (2010) have shown that under commonly used demand specifications, multi-product monopolists do not take demand cross-effects into account. Since we are using similar demand specifications, this result implies that the effect we describe does not occur when retailers are monopolists who do not have to worry about the extensive margin. However, in reality retailers are very rarely pure monopolists, and typically face some competition, in particular on a geographical dimension. We show that in the presence of competition, the cannibalization effect plays an important role in the response of retailing pricing to changes in tariffs.

The rest of the paper proceeds as follows. Section 2 sets up the model. Section 3 characterizes the equilibrium and analyzes the effects of a change in the tariff on a foreign good. Finally, Section 4 concludes.

2 Model

We use a finite version of the Melitz and Ottaviano (2008) utility function.

2.1 Consumers

There is a mass, M, of consumers that are located uniformly along a line segment with one of two retailers ($h = L, R$) at each end. A consumer's location is indexed by $\delta \in [0, 1]$, the distance from the left end of the city. A consumer must choose to buy from one of two retailers and incurs a cost, measured in the numeraire, τd_h^2 where d_h is the distance traveled to retailer h and τ captures all exogenous influences on consumer travel costs, such as infrastructure and consumer mobility. Each consumer has the following utility function for going to retailer h:

$$U_h = q_0 - \tau d_h^2 + \alpha \sum_{i=1}^{N} q_i - \frac{1}{2}\gamma \sum_{i=1}^{N} q_i^2 - \frac{1}{2}\eta \left[\sum_{i=1}^{N} q_i\right]^2 \tag{1}$$

We assume that the consumers have positive demands for the numeraire ($q_0 > 0$) and that the consumer does not realize her decision of q_i has any affect on Q. Consequently, the willingness to pay for variety i is

$$p_i = \alpha - \gamma q_i - \eta Q \tag{2}$$

The demand for a variety by one consumer can be found by inverting (2) and is given by

$$q_i = \frac{\alpha}{\eta N + \gamma} - \frac{1}{\gamma} p_i + \frac{\eta N}{\eta N + \gamma} \frac{1}{\gamma} \bar{p}, \ \forall i \in [1, N] \tag{3}$$

where N is the number of varieties and $\bar{p} = (1/N) \sum_{i=1}^{N} p_i$.

Normalizing the price of the numeraire ($p_0 = 1$), we can see that the indirect utility function associated with a consumer going to retailer h is

$$V_h = I - \tau d_h^2 + \frac{1}{2} \left(\eta + \frac{\gamma}{N} \right)^{-1} (\alpha - \bar{p}_h)^2 + \frac{1}{2} \frac{N}{\gamma} \sigma_{p_h}^2 \tag{4}$$

where I is the consumer's income and $\sigma_p^2 = (1/N) \sum_{i=1}^{N} (p_i - \bar{p})^2$ represents the variance of prices. Armed with the indirect utility function, the location of the consumer who is indifferent between purchasing from retailer L and retailer R (assuming all consumers buy) is the point $\hat{\delta}$ such that

$$I - \tau \hat{\delta}^2 + \frac{1}{2} \left(\eta + \frac{\gamma}{N} \right)^{-1} (\alpha - \bar{p}_L)^2 + \frac{1}{2} \frac{N}{\gamma} \sigma_{p_L}^2 = I - \tau (1 - \hat{\delta})^2 + \frac{1}{2} \left(\eta + \frac{\gamma}{N} \right)^{-1} (\alpha - \bar{p}_R)^2 + \frac{1}{2} \frac{N}{\gamma} \sigma_{p_R}^2$$

or

$$\hat{\delta} = \frac{1}{4\tau} \left[\left(\frac{N}{N\eta + \gamma} \right) \left[(\alpha - \bar{p}_L)^2 - (\alpha - \bar{p}_R)^2 \right] + \frac{N}{\gamma} \left[\sigma_{p_L}^2 - \sigma_{p_R}^2 \right] + 2\tau \right]. \tag{5}$$

2.2 Retailer

We assume that each retailer cannot choose the number of varieties it carries, but only the price of each variety. We further assume that each retailer has an identical constant marginal cost per variety c_i.[1] Without loss of generality, we focus on retailer L; the profit function is

$$\pi_L = M \hat{\delta} \left[\sum_{i=1}^{N} (p_i - c_i) q_i \right]. \tag{6}$$

[1] Note that these varieties need not be identical; e.g. one could carry Coca-Cola and the other Pepsi. However, the distribution of costs across varieties must be identical.

Using the demand for a variety, (3), the profit function becomes

$$\pi_L = M\hat{\delta}\Upsilon_L \tag{7}$$

where

$$\Upsilon_L = \sum_{i=1}^{N}(p_i - c_i)\left(\frac{\alpha}{\eta N + \gamma} - \frac{1}{\gamma}p_i + \frac{\eta N}{\eta N + \gamma}\frac{\bar{p}_L}{\gamma}\right) \tag{8}$$

is the profit per consumer.

3 Equilibrium

To characterize the equilibrium, we need to find the p_k for each retailer that maximizes profits. Differentiating (7) with respect to p_k yields the generic first order condition:

$$\frac{\partial \pi_L}{\partial p_k} = M\left[\Upsilon\frac{\partial \hat{\delta}}{\partial p_k} + \hat{\delta}\frac{\partial \Upsilon_L}{\partial p_k}\right] = 0. \tag{9}$$

As can be seen by equation (9), the retailer has to weigh the effects of a change in the price of variety k on two margins. The first margin is how changing the price affects the indifferent consumer and thus its consumer base – this is given by:[2]

$$\frac{\partial \hat{\delta}}{\partial p_k} = \frac{1}{2\tau}\left[\frac{(p_k - \bar{p}_L)}{\gamma} - \frac{(\alpha - \bar{p}_L)}{N\eta + \gamma}\right] = -\frac{q_k}{2\tau}.$$

Note that if $p_k > \bar{p}$, raising the price of variety k has a positive effect on the market share by increasing the variance of prices, however this is countered by the negative affect of increasing the average price. The second margin is how changing the price affects the profit from each

[2]Note that

$$\frac{\partial \sigma^2_{p_L}}{\partial p_k} = \frac{2}{N}(p_k - \bar{p}_L).$$

consumer in the retailer's consumer base – this is given by:

$$\frac{\partial \Upsilon_L}{\partial p_k} = \left(\frac{N}{\eta N + \gamma}\right)\left[\frac{\alpha}{N} + \frac{\eta}{\gamma}\left[(c_k - \bar{c}) - 2(p_k - \bar{p})\right] + \frac{c_k}{N} - \frac{2p_k}{N}\right].$$

At the optimum, in a symmetric equilibrium, the retailer chooses a vector of prices such that these margins offset each other:

$$\frac{\partial \Upsilon_L}{\partial p_k} = \Upsilon_L \left(\frac{q_k}{\tau}\right) \tag{10}$$

for all k. Summing up over our first order conditions, (10), yields the following relationship:

$$\left(\frac{N}{\eta N + \gamma}\right)\left[\alpha + \bar{c} - 2\bar{p}\right] = \frac{Q\Upsilon_L}{\tau}$$
$$\Rightarrow \left[\frac{\alpha + \bar{c} - 2\bar{p}}{\alpha - \bar{p}}\right] = \frac{\Upsilon_L}{\tau}.$$

Inserting this back into our general first order condition, we can solve for the price of variety k in terms of aggregates:

$$p_k = \frac{(\alpha - \bar{p})}{(\alpha - \bar{c})}c_k + \frac{(\bar{p} - \bar{c})}{(\alpha - \bar{c})}\alpha. \tag{11}$$

Note that the price of variety k depends on both its cost, but also the average cost of all varieties. In the case of the monopolist, the equilibrium average price, $\bar{p}$, is such that the effect from the average cost is canceled out and there are no cross-price effects. However in our case, the equilibrium $\bar{p}$ is nonlinear and more complicated. In particular, the equilibrium $\bar{p}$ solves a cubic function, or identically, it is the solution to this equality:[3]

$$\left[\alpha + \bar{c} - 2\bar{p}\right] = \frac{N(\bar{p} - \bar{c})(\alpha - \bar{p})^2}{\gamma\tau}\left[\frac{\gamma}{(N\eta + \gamma)} + \frac{\sigma_c^2}{(\alpha - \bar{c})^2}\right]. \tag{12}$$

[3]This relationship is derived from the relationship

$$\left[\frac{\alpha + \bar{c} - 2\bar{p}}{\alpha - \bar{p}}\right] = \frac{\Upsilon_L}{\tau}.$$

There does exist an analytical solution to this, however is incredibly long and uninformative. Since our objective is analyze how equilibrium prices change in response to increased trade costs and we are not explicitly concerned with a closed-form solution to p_k, we provide some numerical analysis for clarity, but omit the analytical solution. If we rewrite our equilibrium condition for $\bar{p}$, (12), as two functions, we get $h(\bar{p}^*) = g(\bar{p}^*)$. Plotting these two functions yields Figure 1.

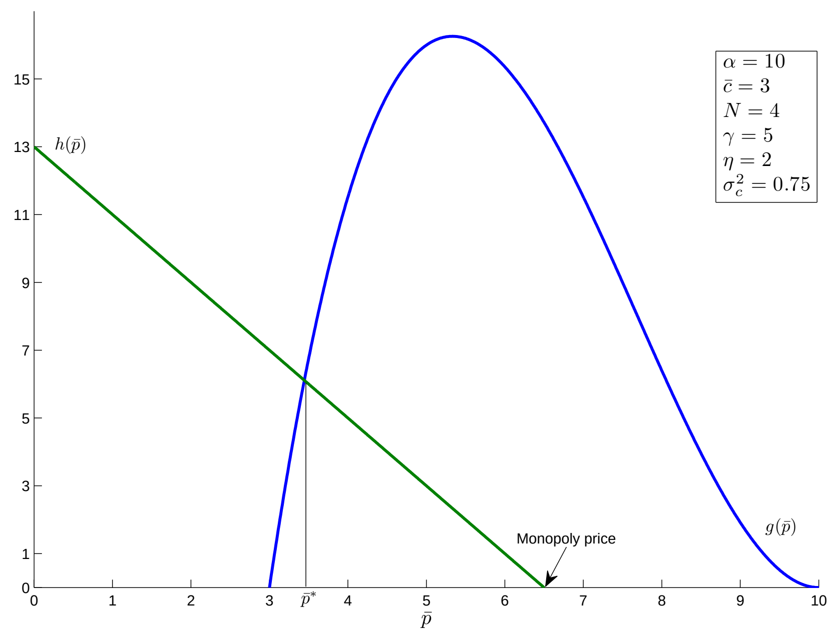

Figure 1: Equilibrium $\bar{p}$

From the parameters chosen, it is obvious that the average price in the duopoly case is less then that of the monopolist which means that the price of each variety is also less then the monopolist.[4] However, this is not a general result and we need to make a further assumption to ensure that we are only using the space of equilibria in which prices are less than the monopoly case. This will be the case, when the maximum value for $g(\bar{p})$ is greater than $h(\bar{p})$. It follows that

$$\arg\max g(\bar{p}) = \frac{\alpha + 2\bar{c}}{3}.$$

[4]We provide a proof of this claim in the Appendix.

Therefore, we assume that

$$1 < \frac{4N}{9\gamma\tau}\left[\frac{\gamma}{(N\eta+\gamma)} + \frac{\sigma_c^2}{(\alpha-\bar{c})^2}\right](\alpha-\bar{c})^2$$

to ensure our retailers chose prices below what a monopolist would choose. To reiterate, our equilibrium is characterized by the following:

$$p_k = \frac{(\alpha-\bar{p})}{(\alpha-\bar{c})}c_k + \frac{(\bar{p}-\bar{c})}{(\alpha-\bar{c})}\alpha \quad \forall k, \text{ and} \tag{13}$$

$$[\alpha+\bar{c}-2\bar{p}] = \frac{N(\bar{p}-\bar{c})(\alpha-\bar{p})^2}{\gamma\tau}\left[\frac{\gamma}{(N\eta+\gamma)} + \frac{\sigma_c^2}{(\alpha-\bar{c})^2}\right]. \tag{14}$$

3.1 Change in tariffs

In this section we investigate the effect on the equilibrium in response to an increase in a tariff charged on a single foreign variety; variety F. We begin with the single variety case to provide intuition. We are particularly interested in the effect this will have on the prices of the other (domestic) varieties. At this point, we remain mainly agnostic as to how a tariff affects the cost of a variety while only assuming $dc_F/dt > 0$ and $dc_k/dc_F = 0$ for any $k \neq F$. Totally differentiating our symmetric equilibrium condition, (10), with respect to c_F yields:[5]

$$\frac{dp_k}{dc_F} = \frac{(\alpha-c_k)}{(\alpha-\bar{c})}\left[\frac{d\bar{p}}{dc_F} - \frac{(\alpha-\bar{p})}{N(\alpha-\bar{c})}\right] > 0 \tag{15}$$

$$\frac{dp_F}{dc_F} = \frac{(\alpha-c_F)}{(\alpha-\bar{c})}\left[\frac{d\bar{p}}{dc_F} + \left(\frac{N-1}{N}\right)\frac{(\alpha-\bar{p})}{(\alpha-\bar{c})}\right] > 0 \tag{16}$$

$$\frac{d\bar{p}}{dc_F} = \Lambda\left[\frac{(\alpha-\bar{p})}{N(\bar{p}-\bar{c})} - \frac{2(\bar{p}-\bar{c})(\alpha-\bar{p})^2}{\gamma\tau(\alpha-\bar{c})^3}\left[(c_F-\bar{c})(\alpha-\bar{c})+\sigma_c^2\right]\right] > 0 \tag{17}$$

where

$$\Lambda = \left(\frac{(\bar{p}-\bar{c})(\alpha-\bar{p})}{(\bar{p}-\bar{c})(\alpha-\bar{c})+(\alpha+\bar{c}-2\bar{p})^2}\right).$$

[5]For exposition, we suppress the term $\left(\frac{dc_F}{dt}\right)$.

These three equations will be the basis for our main analysis in the next section, but first note that there are cross-price effects in our model; i.e. the price of variety k is affected by the price/cost of variety F.[6]

Though we are interested in how retailers adjust their prices of all varieties in response to an increase in the cost of one variety, it is also important to see how the quantity sold of each variety is affected. After all, the quantity demanded of a variety depends on its price *and* the average price. Therefore, we also solve for the changes in quantity:

$$\frac{dq_k}{dc_F} = \frac{1}{\gamma}\left[\frac{N\eta}{N\eta+\gamma}\frac{d\bar{p}}{dc_F} - \frac{dp_k}{dc_F}\right] \lesseqgtr 0 \tag{18}$$

$$\frac{dq_F}{dc_F} = \frac{1}{\gamma}\left[\frac{N\eta}{N\eta+\gamma}\frac{d\bar{p}}{dc_F} - \frac{dp_F}{dc_F}\right] < 0 \tag{19}$$

$$\frac{d\bar{q}}{dc_F} = \frac{-1}{N\eta+\gamma}\frac{d\bar{p}}{dc_F} < 0 \tag{20}$$

It is clear that the quantity demanded of the foreign good decreases as does the average quantity. However, the level changes in quantity for domestic varieties are not identical and depend on each individual price change. This leads us to our first proposition,

Proposition 1. *The gains to domestic manufacturers from trade protection are biased toward the least efficient domestic manufacturers.*

[6] An alternative way of writing down the comparative statics is the following:

$$\frac{dp_k}{dc_F} = \left[\mho\left(\frac{\bar{p}-\bar{c}}{\alpha-\bar{c}}\right)2q_F[\gamma q_k+\eta Q]\right] > 0$$

$$\frac{dp_F}{dc_F} = \left[\mho\left(\frac{\bar{p}-\bar{c}}{\alpha-\bar{c}}\right)2q_F[\gamma q_F+\eta Q] + \left[\frac{\alpha-\bar{p}}{\alpha-\bar{c}}\right]\right] > 0$$

$$\frac{d\bar{p}}{dc_F} = \left[\left[\mho\,(\bar{p}-\bar{c})\,2q_F + \frac{1}{N}\right]\left[\frac{\alpha-\bar{p}}{\alpha-\bar{c}}\right]\right] > 0$$

where

$$0 < \mho = \left[\left(\frac{\alpha-\bar{c}}{\alpha-\bar{p}}\right)\tau + \frac{[\alpha+\bar{c}-2\bar{p}]^2\tau}{(\bar{p}-\bar{c})(\alpha-\bar{p})}\right]^{-1} < 1.$$

Proof. To see this, notice from the comparative static (15) that

$$\frac{dp_k}{dc_F} - \frac{dp_j}{dc_F} = \left[\frac{d\bar{p}}{dc_F} - \frac{(\alpha - \bar{p})}{N(\alpha - \bar{c})}\right][c_j - c_k] > 0 \quad \Leftrightarrow \quad c_k < c_j.$$

Furthermore, it follows from (18) and (19) that

$$\frac{dq_j}{dc_F} - \frac{dq_k}{dc_F} > 0 \quad \Leftrightarrow \quad c_k < c_j.$$

Since, in our model, the gains to domestic manufacturers from protection comes solely from selling greater quantities, this means that these gains are biased towards the least efficient manufacturers. □

In addition to the tariff affecting domestic quantities sold in equilibrium differently based on their productivity, the productivity of the foreign firm matters to the gains of domestic firms. We formally state this in the following corollary.

Corollary 1. *The productivity of the foreign firm matters to the gains of domestic firms.*

Proof. Holding the moments $\bar{p}$ and $\bar{c}$ fixed but allowing where the variety F is in cost distribution to change, it follows that

$$\frac{d^2\bar{p}}{dc_F^2} = -\Lambda\left(\frac{2(\bar{p} - \bar{c})(\alpha - \bar{p})^2}{\gamma\tau(\alpha - \bar{c})^2}\right) < 0,$$

and

$$\frac{d^2 q_k}{dc_F^2} = \frac{1}{\gamma}\left[\frac{N\eta}{N\eta + \gamma} - \frac{(\alpha - c_k)}{(\alpha - \bar{c})}\right]\frac{d^2\bar{p}}{dc_F^2} \lesseqgtr 0. \tag{21}$$

□

The sign of equation (21) also depends on where the domestic firm lies in the cost distribution. If the domestic variety k is more productive than the average ($c_k < \bar{c}$), then (21) will be positive. However, if c_k is sufficiently greater than $\bar{c}$, equation (21) is negative. Another way of interpreting this is that, the more productive the foreign firm is, the less the more productive domestic firms gain and the more the less productive domestic firms gain; all else equal. This is important to point out as the recent literature (e.g. Melitz 2003) has illustrated the most productive firms are the firms that export.

4 Conclusion

In this paper we address the role of adjustments in retail mark-ups for the pass-through of changes in tariff to local consumer prices. We show that retailers have an incentive to shift their mark-ups away from goods that have become relatively more expensive because of a tariff, and towards products that are not subject to the tariffs and have, thus, become relatively cheaper. These shifts in retail mark-ups are counteracting the impact of a tariff on demand for manufactured goods, and have to be taken into account when assessing the effects of a tariff.

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APPENDIX

A Proofs

Proposition A1. *If the average price in the duopoly is less than the average price for the monopolist, the price of each variety for the duopolist is also lower.*

Proof. Proof by contradiction. Let p^D be the price for the duopolist and p^M the monopolist's price. Suppose $p_k^M < p_k^D$:

$$\begin{aligned} p_k^D &> p_k^M \\ \Leftrightarrow \frac{1}{\alpha - \bar{c}}\big[(\alpha - c_k)\bar{p}^D + (c_k - \bar{c})\alpha\big] &> \frac{\alpha + c_k}{2} \\ \Leftrightarrow (\alpha - c_k)\bar{p}^D &> \frac{(\alpha + c_k)(\alpha - \bar{c})}{2} - (c_k - \bar{c})\alpha \\ \Leftrightarrow \bar{p}^D &> \frac{1}{2(\alpha - c_k)}\big[(\alpha + c_k)(\alpha - \bar{c}) - 2(c_k - \bar{c})\alpha\big] \\ \Leftrightarrow \bar{p}^D &> \frac{\alpha + \bar{c}}{2} = \bar{p}^M \end{aligned}$$

This contradicts the assertion that $\bar{p}^D < \bar{p}^M$. □