The Effect of Vertical Structure on Exchange Rate Pass-through

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
[Abstract]

We introduce an explicit incorporation of local distributors in an analysis of pricing behavior of exporting firms in the pricing-to-market literature. We examine pricing behaviors of exporting firms under four different cases of vertical structure; in the case of an independent local distributor and in the cases of local distributors vertically restricted in three forms. From our theoretical model we find that the form of vertical structure for exporting firms has a significant effects on exchange rate pass-through. Since the measure of pass-through has not been distinguished between wholesale price and consumer price in previous researches, we conclude that the reported values of pass-through from previous researches only capture the partial pricing behavior of traded goods. We suggest that further empirical investigation in pass-through associated with consumer price is necessary for complete understanding of the pricing behavior of traded goods.

Keywords: exchange rate pass-through, pricing-to-market, vertical integration.
Journal of Economic Literature Classification Numbers: F12; L12; L22

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1. Introduction

The products of manufacturers go through various stages before purchased by final consumers. For example, a movie film produced by a studio (manufacturer) in Hollywood will be distributed by both domestic and foreign film distributors (wholesalers) to local movie theaters (retailers) all over the world. As a final consumer we can consume these products in different final forms; we go to see a movie at theater or pick up a video at a rental shop. These vertical structures can be in different forms among different industries and at different points of time in the same industry.

As observed in the above example, in international trade the manufactured goods must go through distributors of a destination country. What distinguishes the manufacturers in providing a film to the domestic film distributors, on the one hand, and the foreign film distributors, on the other, is the presence of fluctuating nominal exchange rate in international trade. In response to exchange rate fluctuations, many empirical evidences have accumulated to confirm the claim that the exporter conducts different pricing strategies for different national markets. For example, in his panel regression for the export pricing by U.S. and German exporters, Knetter (1989) found the importing country effects significant. Knetter, therefore, concludes that these exporters employ pricing-to-market strategies, termed by Krugman (1987)[1]. Similar evidences are found in Ohno (1989), Marston (1990), Hung, Kim and Ohno (1993) and Gagnon and Knetter (1995).

Despite the fact that these research only focus on the behavior of exporters, the role of import distributors in international trade is also recognized in the literature to influence the magnitude of exchange rate pass-through. For example, from indirect evidences of exchange rate coefficient being significant in the import deflator equation but not significant in the consumption deflator, Woo (1984) conclude that dealers of foreign products also engage in adjustment of markup over cost with exchange rate fluctuations. Also, Kasa (1992) notes a caveat that the use of a marketing subsidiary by a parent firm may bias the estimation of pass-through in his paper. More strikingly, Gagnon and Knetter (1995) find direct evidence of retailers for Japanese and German

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[1] Seminal papers on pricing-to-market literature and pass-through literature are Krugman (1987) and Dornbusch (1987). Among others, Baldwin (1988), Baldwin and Krugman (1989) and Dixit (1989) uses a model in a dynamic framework; Froot and Klemperer (1989) with a market share model; Kasa (1992) with an adjustment cost model. For the survey, see Yoshida (1997).

automobile adjusting markup with exchange rate fluctuations. With limited number of products, Yoshida (1994) conducts co-integration analysis between wholesale price and consumer price of imports in Japan. These research, nonetheless, lacked a concrete model of vertical structure in international trade settings.

Lacking vertical structures in a model, it is not obvious how the form of vertical structure affects the level of exchange rate pass-through. More precisely, the literature does not provide a clear description of what happens to the exchange rate pass-through if an exporter, previously relying on an independent foreign distributor, sets up its own subsidiary distributor in a foreign country. This can be very important aspect from the view of foreign direct investment literature. In order to answer these questions in a satisfactory manner, we need to construct a model with an explicit incorporation of distributors in international trade. After setting up a vertical structure model, we give the first explicit analysis of the effect of vertical structure on exchange rate pass-through.

Simultaneously, another complication arises when one focuses closely into the vertical structure of international trade. With international trade involving local distributors, there are two different export prices; wholesale price determined between exporters and distributors and retail price set between distributors and consumers. Exchange rate pass-through must be clearly defined with these export prices respectively in order to gain a correct assessment on the export price behavior. The effect of vertical structure on exchange rate pass-through is distinguished for these export prices in our analysis.

Conforming to the literature, we concentrate on industries with differentiated products in the followings; we assume that manufactures are monopolistic exporters. In addition, we assume that there is a single distributor for an exporter, although we later discuss how far we can relax this assumption without alternating the major results.[2] It is natural to assume that the sole distributor marketing the differentiated products can also act as a monopolist in the final market.[3] What we observe in this industry is, then, the international version of successive monopolies. In the successive

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[2] For example, the same results can be obtained for multiple distributors, if each distributor is only allowed to deal in his exclusive territory.

[3] The nature of imported goods often make themselves differentiated products in the market. The name of country where the imports are manufactured often reflects as a 'brand' to the consumers. See Froot and Klemperer (1989) for their discussion on brand.

monopolies literature it is well-established that a monopolistic firm has incentive to integrate vertically forward, see Spengler (1950). The upstream firm (manufacture) can gain extra rents from eliminating negative externality of a higher price than monopoly price by vertically integrating forward with the downstream firm.

The various forms of vertical restraints instead of vertical integration can be also implemented to achieve the same outcome for the manufacturers. In the following analysis we consider the effects of vertical integration, franchise contract, and resale price maintenance on exchange rate pass-through. Franchise contract, in which franchisee follows fixed royalty fee and revenue sharing, can be used to eliminate the vertical externality which emerges for the case when both upstream firm and downstream firm must contribute to such quality improving input as advertisements[4]. Mathewson and Winter (1985) provides in a general setting when franchising contract is necessary to avoid free-riding problem for a vertical relation. The economic incentive for the use of resale price maintenance is given in Mathewson and Winter (1983), Marvel and McCafferty (1984) and Romano (1994). In general the sales efforts made by retailers produce positive horizontal externality, therefore, there is a free-rider problem for the exporter. Resale price maintenance can be used to eliminate this problem among retailers.

In the following section we present our successive monopolies model with a few formal assumptions. In section 3 we distinguish two measures of exchange rate pass-through with regard to wholesale level price and consumer level price. These two different measures have not been clearly distinguished in the literature. We derive these pass-through measures for different settings of vertical structure, between independent firms and between vertically integrated firms. In section 4 we summarize how the vertical structure affects the size of exchange rate pass-through under the general demand form and under a linear-demand form. From our theoretical model we find that the form of vertical structure for exporting firms has a significant effects on exchange rate pass-through. Section 5 reconsiders the framework of successive monopolies and discusses how far our analysis can be extended to a more general setting without altering the result obtained in this paper. In the concluding section, we discuss the implication of our results relating to the previous studies in the literature of pass-through and pricing-to-market. Overall message of this paper is that we need further investigations on exchange rate pass-through with regard to consumer

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[4] Mathewson and Winter (1985) notes that franchising accounts for approximately one-third of total retail sales in the United States and Canada.

price in order to obtain a general description of export price behavior.

2. The Model of Successive Monopolies

We assume an exporter as a monopoly selling his products in a foreign market through a single local distributor. The exporter faces a constant marginal cost for producing his product and sets a wholesale price in terms of the home currency. The foreign distributor, on the other hand, takes as a marginal cost the wholesale price denominated in the foreign currency and becomes a single supplier of the product in the local market. For simplicity, we assume for the foreign distributor without a loss of generality that costs for distributing and adverting are zero[5]. These two firms together contribute successive monopolies in international trade framework.

The profits for these upstream firm and downstream firm in explicit forms are[6],

$$
\begin{aligned}
\pi^U &= (p_W - c)q \\
\pi^D &= (p - ep_W)q
\end{aligned}
\tag{1}
$$

where the exchange rate, e, is expressed as the foreign price of home currency. π^U and π^D are the profits of the exporter and the distributor respectively. q is the demand function for the export products and p is the consumer price in the foreign currency. p_W and c are the wholesale price and a constant marginal cost[7] in the home currency.

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[5] The lack of cost function, besides purchasing cost from exporters, on distributors needs a few remarks. The presence of cost unresponsive to exchange rate changes is an important determinant of incomplete pass-through. Because the local production at the export market is free of exchange rate shocks, Gron and Swenson (1996) estimated pass-through coefficients of exporters with inclusion of the share of domestic production and foreign production. The presence of local distributors for exporters works in a similar way with the local production for the exchange rate pass-through. We have examined our model with an explicit inclusion of a local constant marginal cost and obtained the same result. So we suppress this cost for the sake of clear exposition.

[6] The pricing-to-market literature assumes that the exporter provides its supply for both domestic market and export market. However, the presence of domestic market can be suppressed in the following analysis, if the marginal cost is constant.

[7] In a more general form of cost function, we will have to come up with a more

For the information structure of the model, we assume throughout this paper that the exporter has a perfect information of the profit function of the foreign distributor and the demand function.   More precisely, we only need to require in the following analysis that the exporter knows the foreign distributor's perception of the demand function. Although this is not a good approximation of the international trade environment, we assume this information structure in order to exemplify the direct effects of vertical structure on the exchange rate pass-through.   The exporter, for example, can be thought to gain information on foreign market from purchasing the market research report.

However, we need to assume a rather strict assumption on the form of the demand function.

Assumption 1. [demand function]   The demand function is three times differentiable and monotone decreasing in p.   Its first derivative is strictly decreasing and second derivative is non-increasing in p. $q = q(p),$ *where* $q'(p) < 0$ $q''(p) \leq 0$.

These assumptions are not unfamiliar; they are satisfied if the demand function is concave.   The additional restriction on the third derivative is necessary to provide a derived demand with similar properties of the original demand function.

Assumption 2. [demand function] $q''' \geq \dfrac{(q'')^2}{q'}$

The above assumption is somewhat awkward, however, since the sign of the right hand side is negative, it is less strict a restriction than the one requiring the non-negativity of the third derivative of demand with respect to price.   For example, the linear demand function satisfies both assumptions.

We are now ready to provide the property of derived demand function for the exporter in the following lemma.

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complicated form of assumptions.   Since our main concern is on the effect of vertical integration upon exchange rate pass-through, we avoid unnecessary complications of our model for the sake of exposition.

Lemma 1. [derived demand] With assumption 1, the derived demand, $\bar{q} = \bar{q}(ep_W) = q(p(ep_W))$, of the distributor is strictly decreasing in ep_W. In addition, with assumption 2 the first derivative of the derived demand is non-increasing in ep_W.

$$\bar{q}'(ep_W) < 0 \qquad \bar{q}''(ep_W) \le 0.$$

Proof: See the appendix.

We note that these two assumptions are not necessary for our main conclusion, i.e., vertical structure matters for pass-through; they are only required to let us concentrate on an incomplete exchange rate pass-through case which we are most likely to observe in the accumulated evidences.   For example, if the demand function is more convex than constant elasticity curve, we would observe an exchange rate pass-through elasticity to be larger than unity.   In this case the price is showing more responses than in a complete pass-through case.   Although we also sometimes encounter these cases in some specific products or industries in empirical research, we would find it difficult to be accepted as the model in the relatively long-run case.   Therefore, we proceed to restrict our analysis in the rest of the paper with these assumptions.

With these assumptions formally stated now, we can examine the determination of exchange rate pass-through in the successive monopolies model.   As we mentioned in the introduction, in the successive monopolies model an upstream firm has incentive to eliminate negative vertical externality by vertically integration or other vertical restraints.   Whether an upstream firm may actually use these vertical restraints on downstream firm mainly depends upon the cost of implementing these restraints relative to the gain from elimination of negative externality.   Therefore, many research in the literature of vertical integration focuses on the cost of integration and monitoring in order to understand coexistence of vertically integration and vertically separation in the economy (see e.g., Lafontaine and Slade (1996))[8].   In this paper, however, we neglect this issue and focus on the effect of these various vertical restraints, if so chosen by the exporter.   Our aim in this paper is, therefore, to describe how different vertical structures affect the price movements with respect to exchange rate fluctuations.

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[8] Bonanno and Vickers (1988), Maness (1996) and Lafontaine and Slade (1996, 1997) investigate causes that influence the firm's decision on whether to integrate or to franchise.

3. Exchange Rate Pass-through

With the property of the derived demand function obtained above, the upstream firm (exporter) maximizes its profit. With our assumptions we conform the main result in the pass-through literature that the wholesale price of imports in terms of the importer's currency does not fully reflect changes in the exchange rate. In the following analysis, we must, at first, define two measures of the exchange rate pass-through and a complementary measure of pass-through: (ε^W) exchange rate pass-through on wholesale price; (ε^C) exchange rate pass-through of consumer price;(η) wholesale price pass-through on consumer price.

Definition. [exchange rate pass-through at different stages]   Exchange rate pass-through of wholesale price (=ε^W) (consumer price (=ε^C))is defined as the ratio of the proportional change in the wholesale (consumer) price in the foreign currency to the proportional change in the exchange rate. Wholesale pass-through of consumer price (=η) is the ratio of the proportional change in the consumer price in the foreign currency to the proportional change in the wholesale price in the foreign currency.

$$\varepsilon^C = \eta \cdot \varepsilon^W \quad where \quad \varepsilon^C = \frac{dp}{de}\frac{e}{p}, \quad \varepsilon^W = \frac{dep_W}{de}\frac{e}{ep_W} \quad and \quad \eta = \frac{dp}{dep_W}\frac{ep_W}{p}.$$

Most of the empirical work on the pass-through and pricing-to-market literature use price measure of imports or exports from custom data and their measure of pass-through, corresponding with our definition of ε^W. However, we argued in the introduction that interpreting international trade based only on this measure of pass-through is misleading. In the following analysis we will show formally how three measures of pass-through would differ from each other. We also show how various vertical structures would influence these three measures of pass-through in the following subsections (i) to (iv).

(i) Independent monopolies

In this subsection we derive the explicit terms for three measures of exchange rate pass-through with two independent firms. If an exporter decides to develop a new market overseas, the exporter can contract with the existing foreign distributors or establish its own distributor. However, at the early stage of developing a new market,

it is most likely for the exporter to rely on the existing foreign distributors. This corresponds to the case of two independent firms in our analysis.

The following two lemmas establish the property of three measures of exchange rate pass-through when the manufacturer and the distributor are independent; all the pass-through are less than unity are derived with our assumptions.

Lemma 2. [incomplete ε^W with two independent firms] If a monopoly exporter and a monopoly distributor are independent in their vertical relationship, with the demand function satisfying assumption 1 and 2, the exchange rate pass-through of wholesale price, ε^W, is incomplete, i.e., strictly less than unity.

$$\frac{d(ep_W)}{de} = \frac{c\overline{q}'}{2p_W\overline{q}'+ep_W(p_W-c)\overline{q}''} < 1 \tag{2}$$

Proof: We first use the derived demand function to rewrite the profit function of the upstream firm, $\pi^U = (p_W - c)\overline{q}$. The first order condition for optimizing the profit is, $ep_W\overline{q}'-ec\overline{q}'+\overline{q}=0$. Totally differentiating this condition, we obtain $[e\overline{q}'+e^2 p_W\overline{q}''-e^2 c\overline{q}''+e\overline{q}']dp_W + [p_W\overline{q}'+ep_W^2\overline{q}''-c\overline{q}'-ep_W c\overline{q}''+p_W\overline{q}']de - [e\overline{q}']dc = 0$.

Letting dc=0 and rearranging the terms, we obtain $\frac{dp_W}{de} = -\frac{[ep_W(p_W-c)\overline{q}''+(2p_W-c)\overline{q}']}{[e^2(p_W-c)\overline{q}''+2e\overline{q}']} < 0$. The inequality is satisfied because we use in addition to the property of the derived demand function that the equilibrium wholesale price is higher than marginal cost. Since the exchange rate pass-through is defined in the foreign currency denomination, we obtain the derivative of the wholesale price in the foreign currency with respect to the exchange rate, $\frac{dep_W}{de} = p_W + e\frac{\partial p_W}{\partial e} = p_W - \frac{[ep_W(p_W-c)\overline{q}''+(2p_W-c)\overline{q}']}{[e(p_W-c)\overline{q}''+2\overline{q}']} = \frac{c\overline{q}'}{[e(p_W-c)\overline{q}''+2\overline{q}']} > 0$.

Finally, we obtain the terms for the exchange rate pass-through elasticity, $\frac{d(ep_W)}{de}\frac{e}{ep_W} = \frac{c\overline{q}'}{2p_W\overline{q}'+ep_W(p_W-c)\overline{q}''} < \frac{c\overline{q}'}{c\overline{q}'+ep_W(p_W-c)\overline{q}''} \le \frac{c\overline{q}'}{c\overline{q}'} = 1$. For the first inequality, we used $p_W > c$. This proves the lemma. Q.E.D.

The most empirical studies in the pricing-to-market literature concentrate on the empirical findings of the statements of the lemma above. For example, Feenstra and etc. (1996) use export unit values to measure exchange rate pass-through. Kasa (1992) uses custom data. Their measures of exchange rate pass-through are ε^W. Before the

emergence of the pricing-to-market literature, there were, of course, numerous analyses of pass-through with consumer price index[9]. However, no clear distinction was made between these two values; they are often used as a proxy for each other. Lemma 3 requires that we distinguish the two different pass-throughs in the analysis.

Lemma 3. [$\varepsilon^C < \varepsilon^W$ with two independent firms] Moreover, the exchange rate pass-through of consumer price is even smaller than the exchange rate pass-through of wholesale price.

Proof: The exchange rate pass-through elasticity of consumer price is $\frac{dp}{de}\frac{e}{p} = \frac{\partial p}{\partial ep_W}\frac{\partial ep_W}{\partial e}\frac{e}{p} = \frac{\partial p}{\partial ep_W}\frac{ep_W}{p}\frac{\partial ep_W}{\partial e}\frac{e}{ep_W}$. We have already obtained the last terms for the right hand side of the equation. By using price over marginal cost inequality,

$$\frac{\partial p}{\partial ep_W}\frac{ep_W}{p} = \frac{ep_W}{p}\frac{q'}{(2q'+(p-ep_W)q'')} = \frac{ep_W q'}{2pq'+p(p-ep_W)q''} \leq \frac{ep_W q'}{2pq'} < \frac{ep_W q'}{pq'} < \frac{ep_W q'}{ep_W q'} = 1$$

This proves that the exchange rate pass-through of consumer price is smaller than the pass-through of wholesale price. Q.E.D.

In deriving the relationship between two exchange rate pass-through, we also established that all three forms of exchange rate pass-through are incomplete, since $\varepsilon^C = \eta \cdot \varepsilon^W$.

(ii) Vertical integration

In contrast to the previous subsection, the exporter might consider establishing its own subsidiary distributor or vertically integrate forward with the foreign distributor, for example, if it decides to continue to export to the foreign market after acquiring enough shares in the market. Without such losses as exiting from the market after establishing specific investments in the foreign market, the upstream firm in the successive monopolies has the incentive to vertically integrate forward with the

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[9] However, the index used in the empirics consists of the consumer prices of domestic goods as well. It is obvious that one can not obtain a correct measure of exchange rate pass-through with these indices.

downstream firm.   After integration, the exporter can enjoy the joint profit maximization.

The vertical integrated profit in terms of the foreign currency is expressed as follows, $\pi^V = (p^V - c)q(ep^V)$.   Although we could define the profit in terms of the foreign currency as well, since price, quantity and pass-through obtained in the equilibrium are the same under both definitions, we chose to express the profit in terms of the home currency for convenience of exposition.   With the vertically integrated firms, we can only define exchange rate pass-through of consumer price because there is no wholesale price[10].

Lemma 4. [incomplete pass-through with vertical integration] If a monopoly exporter and a monopoly distributor is vertically integrated, the exchange rate pass-through of consumer price is strictly less than unity.[11]

$$\frac{dep}{e}\frac{e}{ep} = \frac{cq'}{2pq' + ep(p-c)q''} < 1 \tag{3}$$

proof: The vertical integrated profit is $\pi^V = (p-c)q(ep)$, where p in this case is an export price denominated in the home currency.   Note that we omit the superscript v in this proof.   The first order condition for the profit is $e(p-c)q' + q = 0$.   Totally differentiating this condition, we obtain $(e^2 pq'' + eq' - e^2 cq'' + eq')dp + (pq' + ep^2q'' - cq' - ecpq'' + pq')de - (eq')dc = 0$.   Letting dc=0 and rearranging the terms, we obtain $\frac{dp}{de} = -\frac{[ep(p-c)q'' + (2p-c)q']}{[e^2(p-c)q'' + 2eq']} < 0$.

Since
$$\frac{dep}{de} = p + e\frac{\partial p}{\partial e} = \frac{ep(p-c)q'' + 2pq' - ep(p-c)q'' - (2p-c)q'}{[e(p-c)q'' + 2q']} = \frac{cq'}{e(p-c)q'' + 2q'} > 0, \quad \text{we}$$

obtain the term for the pass-through, $\frac{dep}{de}\frac{e}{ep} = \frac{cq'}{2pq' + ep(p-c)q''} < \frac{cq'}{cq' + ep(p-c)q''} \leq \frac{cq'}{cq'} = 1$.   We have proved that the pass-through elasticity is less than unity.   Q.E.D.

We attempted to compare the size of exchange rate pass-through elasticities obtained

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[10]   The firm actually does have the wholesale price as an internal transfer price.   We return to the determination of internal transfer price in subsection (vi).

[11]   In this lemma we deleted a superscript (v) on price for the convenience of exposition.

in lemma 3 and lemma 4, however, we could not obtain unambiguous relationship between them with our simple assumptions. With an additional assumption of a linear demand in section 4, we give an exact description of these relative sizes of pass-through elasticity for different vertical structures.

(iii) resale price maintenance

The exporter can realize the integrated profit without integration by using other vertical restraints. In this subsection and the following, we consider how other vertical restraints might affect the pass-through, namely resale price maintenance and franchising. Even though resale price maintenance is implemented when there is fear of free-riding on horizontal externality generated by other distributors' service inputs, we suppress here the service inputs by distributor for the purpose of maintaining the outcome comparable with other cases. Resale price maintenance is a vertical restraint in which an exporter enforces the common consumer price among distributors. (See Mathewson and Winter (1983), Marvel and McCafferty (1984) and Romano (1994)) In the case of single distributor considered in this paper, resale price maintenance is equivalent to set the consumer price equal to the price determined by optimization of vertically integrated firms profit, i.e., $p = ep_W = ep^V$. We note that the consumer price is not, contrary to the impression that the terms might suggest, maintained constant with the fluctuating exchange rate. Resale price maintenance is the mechanism for an upstream to maintain common retail price among downstreams, but it does not necessarily keep resale price constant intertemporally.

Lemma 5: [pass-through elasticities with resale price maintenance] If an exporter imposes resale price maintenance defined above, the exchange rate pass-through on wholesale price and that on consumer price is equivalent to the exchange rate pass-through on consumer price with the integrated firms.

Proof: The exporter with imposition of resale price maintenance faces the same profit function with the vertically integrated firms. The exchange rate pass-through elasticity of wholesale price is obviously equivalent with the exchange rate pass-through elasticity with the vertically integrated firms, $\dfrac{dep_W}{de}\dfrac{e}{ep^W} = \dfrac{dep^V}{de}\dfrac{e}{ep^V}$. For the exchange rate pass-through elasticity of consumer price, since

$\dfrac{dp}{dep^W}\dfrac{ep^w}{p}=\dfrac{dep^V}{dep^V}\dfrac{ep^V}{ep^V}=1$, it is also equivalent to that with the vertically integrated

firms. Q.E.D.

The result in lemma 5 is very obvious if we look at the definition of resale price maintenance. Since the consumer price is always adjusted equal to the wholesale price, η must be unity. This price equivalence also suggests that the exporter is directly determining the final price for the consumers, and because this is the same environment as in the vertically integrated firms' case, we obtain the same exchange rate pass-through on consumer price as in the vertically integrated case.

(iv) franchising contract

Another tool of vertical restraints for the exporter is to impose two-part tariff which consists of a franchise fee and marginal price equal to marginal cost to the exporter (See Mathewson and Winter (1985)). As analogous to the previous subsection, we suppress the service inputs by both exporter and distributor in order to maintain the outcome comparable with other cases. With a given exchange rate, e, the two-part tariff can be written as follows; $T(q)=eF+ecq$ where $eF=\max\limits_{p}\pi^{D}$. The exporter leaves all incentive to the distributor and absorbs all the rent by requiring fixed fee equal to the profit of distributor. With this two-part tariff, we rewrite the profit functions of the exporter and the distributor.

$$\pi^{U}=F$$
$$\pi^{D}=pq-T(q)$$

Lemma 6: [pass-through elasticities with franchise fee]   If a monopoly exporter imposes the two-part tariff defined above, the exchange rate pass-through on wholesale price is complete and the exchange rate pass-through of consumer price is equivalent to the one with the integrated firms.

Proof: Since   the   wholesale   price   is   set   to   constant   marginal   cost, $\dfrac{dep^W}{de}\dfrac{e}{ep^W}=\dfrac{dec}{de}\dfrac{e}{ec}=1$. A change in the exchange rate will be fully passed onto the whole sale price in terms of the foreign currency. For the latter part in the lemma, we

rearrange the profit function of the downstream firm, $\pi^D = pq - T(q) = (p - ec)q - eF$. Because the fixed portion of the two-part tariff does not appear in the first condition, downstream firm profit maximization is equivalent to that of the vertically integrated firms. They differ only by the currency denomination. The exactly same process in the proof of lemma 4 yields the exchange rate pass-through elasticity of consumer price.   Q.E.D.

We now derived pass-through for vertically independent firms, vertically integrated firm, resale price maintenance and franchise contract. Rather than concentrating on explain why the exporter chooses a particular vertical structure among others, we investigated how a particular vertical structure influences two measures of pass-through. In the following section, we summarize our results and discuss implications.

4. The Effects of Vertical Restraints on Exchange Rate Pass-through

Summary of the results in the preceding section is shown in table 1. Three measures of pass-through defined in section 3 are listed with respect to each vertical structure. The term "complete" in the cell refers that the corresponding pass-through is unity; for the exchange rate pass-through, the percentage change in price is equal to the percentage change in the exchange rate. The term "incomplete" refers that pass-through is less than unity. The relative size of "incomplete" between different numbers of asterisks can not be uniquely determined. We review our results and discuss the important implications in the followings.

First, in all cases the pass-through on consumer price is smaller than the pass-through on wholesale price due to the identity $\varepsilon^C = \eta \cdot \varepsilon^W$ and ε^C being less than one. This is not the result we emphasize because we admit this is entirely due to the assumptions. In fact, we intended to restrict our analysis in this incomplete pass-through on consumer price case, because this is the casual observation reported in many cases, e.g., see Gagnon and Knetter (1995). Our objective is to show that under these assumptions, which is implying incomplete pass-through on consumer price, the form of vertical structure could affect the level of pass-through.

Second, the level of pass-through can vary significantly depending upon which measure of pass-through is chosen. Only in the case of resale price maintenance, the exchange rate pass-through on consumer price and wholesale price coincide. This implies that researchers must carefully choose correct pass-through measure matched

for the purpose of research. If the aim of research is, on the one hand, to determine the inflationary impact of exchange rate depreciation on domestic price deflator, the measure of pass-through on consumer price must be chosen. On the other hand, for the evaluation of price impact of depreciation on trade balance, data sample must be taken from the custom report.

Third, we notice that the discretional price setting of vertical integration case, in the absence of legal restrictions and moral hazards, can make the levels of pass-throughs for vertical integration to include the levels of pass-throughs for resale price maintenance and franchising. From the perspective of explanation described below, however, we can interpret vertical integration as an intermediate case.

Fourth and the most important implication to the previous literature, the exchange rate pass-through on wholesale price can be different with respect to various vertical structures even if the exchange rate pass-through on consumer price are the same. Considering that original interest in the PTM literature focuses on revealing or explaining consumer price differentials, measured in common currency, among countries, the examination of behaviors of exporters based on custom data for their proxy can be misleading. For the only exception, Gagnon and Knetter (1995) has examined retail price for specific models of automobiles to see if subsidiary dealers of German automobiles in U.S. has shown to absorb additional proportion of changes in the exchange rate. They found that German automobile dealers show less pass-through at retail level than Japanese automobile dealers even if Japanese automobile manufactures show less pass-through at wholesale level than German automobiles.

(i) a linear demand example

Our main results become clearer if we introduce a widely used specific demand form. We derive exchange rate pass-through elasticity for the cases of two independent firms and vertically integrated firms with a linear demand function, $q = d - p$. We note that a linear demand function satisfies our assumption 1 and 2 in section 2. As an approximation, we only need to require linearity on demand function to hold locally at the optimum price level.

Proposition 1. [pass-through elasticities with a linear demand] With a linear demand function, vertical integration leads to a higher exchange rate pass-through elasticity of consumer price. More precisely, the exchange rate pass-through elasticity of consumer

price (ε^C) with vertically integrated firms is equal to the exchange rate pass-through elasticity of wholesale price (ε^W).

Proof: See the appendix.

Combining the result of the proposition and the lemmas, we could determine the exact relationship of exchange rate pass-through in each vertical structure. Table 2 summarizes the results with a linear demand function.

The first and the second cells in vertically integrated firms column indicates that the pass-through takes any values within the interval between x and unity. Since the wholesale price in vertically integrated firms is just an internal transfer price, it does not affect the firms' overall profit in our framework. However, for example, when a domestic corporate tax is different from the one in a destination country, vertically integrated firms have strong incentive to take some form of pricing strategy. The presence of ad valorem tariff gives another incentive for the firm to choose the lower level of wholesale price to reduce tax payments. However, legal requirements prohibit such pricing behaviors of tax evasion. Since $\varepsilon^C = \eta \cdot \varepsilon^W$ and our previous assumptions of not allowing exchange rate exceeding unity yields the range of pass-through.

5. More Generalized Frameworks

For the purpose of clear exposition of pure impact of vertical structure on exchange rate pass-through, we assumed a rather simple vertical structure in which a distributor is the sole retailer for an imported good. Rather than a monopolistic retailer, casual observations of retail markets seem to suggest that there are many distributors for each imported good. Therefore, some of us might find it doubtful that the results of this paper hold for other retail market structures and conclude that, at the best of interpreting the results of this paper, it reveals the effect of vertical restraints on the exchange rate pass-through only for the special market structure, namely successive monopolies. Nonetheless, in the followings, we argue for the possibility of a wider applicability of our analysis in international trade. In fact, it can be shown that our model of successive monopolies can be extended to cover more generalized frameworks.

First of all, the number of distributors can be extended to infinitely large number of distributors, which in return implies perfect competition. If distributors are perfectly

competitive firms, the consumer price is eventually forced down to equalize with marginal cost, that is, the wholesale price. In this perfect competitive case, the exporter can determine the consumer price through indirect way in contrast with the direct determination of consumer price in the case of resale price maintenance. The distinctive feature in a perfectly competitive distribution market is that the exporter need not to force distributors to an universal resale price; it is the competitive force of the market which realizes a universal resale price in consumer market.

Secondly, it is noteworthy that our analysis can be applied to multiple distributors in limited cases in which the imported market is divided into several spatially separated markets. Under the maintained assumption of constant marginal cost, the profit of exporter can be stated as $\pi^U = \sum_{i=1}^{N}(p_W^i - c^i)q^i$. Then, the optimization problem for the exporter is to choose a price vector instead of a scalar price in the previous analysis. Proceeding analogously for each market, we obtain the same effects of vertical restraints on the exchange rate pass-through in each market. Nevertheless, in a more complicated case of imperfect market structures, each distributor considers the effect of its action on the behavior of other distributors. The analysis, then, requires oligopolistic framework which integrates the interactions of distributors in downstream market; straightforward extension of our results obtained from a monopolistic retailer assumption may not be well applied to the case of oligopolistic retailers.[12]

Moreover, the bargaining power between the exporter and the distributor can be easily relaxed for other possible vertical structures. For example, moving away from the extreme case of the exporter having all the power, we can examine the case of bilateral monopolies in which wholesale price must be determined by some process of bargaining. Providing the full description of this general case is not the aim of this paper, however, we give a brief description for one particular case, which has an important implication especially to the literature of pricing-to-market.

If neither the exporter nor the distributor has the bargaining power, more appropriately put, when neither firms has the market power, that is perfect competition in export market, then the export price is solely determined by the domestic market of exporting country as described in footnote 5. In this case the exchange rate pass-through on wholesale price can be shown to be complete because the export price in

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[12]   For the general discussions of strategic interactions in retail market, see Tirole (1988). Greenhut and Ohta (1979) provides an analysis for successive oligopolies. Gal-Or (1991) and Bonanno and Vickers (1988) analyze the case for oligopoly manufactures.

terms of the exporting country is fixed and the exchange rate pass-through on consumer price is incomplete with our assumption of demand function. Moreover, the particular level of pass-through turns out to be exactly equal to the case of franchising. The loss of market power by the exporter results in that the whole rent is captured exclusively by the distributor.

Lastly, distributors in our analysis do not necessarily refer to retailers in consumer markets. As shown in the introductory part of this paper referring to movie industry, the distribution system may constitutes many layers of distributors. Then, it is most likely that the presence of a monopolistic firm in one layer of the distribution system can introduce the framework of our analysis. It is likely that the importer with private information about the quality of imported goods or wholesaler granted with exclusive dealing in the country, for example, may exhibit the monopoly power.

6. Concluding Remarks

As a result of our successive monopolies model, we obtained without referring to a specific form of demand function that vertical integration affect export price determination along vertical structure. Although the effects of vertical integration on exchange rate pass-through can not be determined unambiguously without further specification of demand function, we obtain with a linear demand approximation that vertical integration increases the degree of exchange rate pass-through on the consumer price of imported goods.

One strong implication of this result is on the welfare of risk-averse consumers. On the one hand, vertical integration improves consumers welfare through eliminating negative externality between two independent firms and it, therefore, leads to a lower equilibrium price and a larger quantity. On the other hand, vertical integration reduces consumers welfare because consumers must confront higher price variability. Welfare improvement generated from the vertical integration of successive monopolies are, therefore, smaller in the international framework in which extremely high volatile nominal exchange rate dominates the shock of other factors such as production cost which largely determines the behavior of prices in the local market.

Moreover, we have obtained a testable hypothesis that the exchange rate pass-through on wholesale price varies with vertical structure whereas the exchange rate pass-through on consumer price is similar over various vertical structures. More precisely, at the consumer price level the price behaviors of exported goods are same for

any vertical restraints we considered in the paper; only for independent firms the import price demonstrates a different behavior. So far empirical studies on pricing-to-market is mostly conducted with wholesale price of exported goods, which is estimating ε^W in our definition, it is recommended that we obtain more empirical evidences on ε^C and η for more complete understandings of international trade.[13]

We should also be able to observe a dynamic change in the pass-through elasticity if the vertical relation of firms changes to another form of vertical relation. For example, at the initial stage of entering to a new market in a foreign country, the exporter is very likely to rely upon the incumbent distribution system in the foreign country. As the products of the exporter establishes its substantial share in the foreign market, the benefit of vertical integration might exceed the cost of vertical integration such as administrative cost, risk of failure to integrate or a possible future withdrawal from the foreign market. Then, exporters might decide on a foreign direct investment in distribution sector. As a result we might be able to observe drastic changes in pass-through, following changes in vertical relation.

The result of this paper implies that conclusions entirely based on the statistical evidence of pricing-to-market only with custom data are far from complete. For the worst, it might lead to misinterpretation of international trade. For example, it is possible that we observe complete pass-through at custom level data for one exporter and incomplete pass-through for another exporter, even if observed pass-through on retail price for both exporter are the same. In our simple model, this case refers to the exporter with franchise distributors and the exporter with distributors under resale price maintenance. From the view of conventional wisdom, however, the former exporter might be labeled as competitive firm and the latter as monopolistic firm. We therefore need to be very careful on conducting policy debates based on the empirical evidence of the previous literature.

Although we assumed a symmetric information structure between the exporter and the distributor in a static setting without uncertainty, a more realistic model of vertical structure should include private information of the distributor about the consumer market and the dynamic framework in which the timing of contracts and realization of exchange rate become important. Extending our analysis straightforwardly in this line must involve the analysis of principal-agent framework in which the exporter

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[13] There are some reports on the values of ε^C, however, the data used for the estimation of these values are usually consumer price indices which include a large share of domestic products.

provides an incentive for the distributor.

Appendix:

<u>Proof of lemma 1</u>

The first order condition for the distributor is $(p - ep_W)q' + q = 0$. Totally differentiating this condition, we obtain $(pq'' + q' - ep_W q'' + q')dp - q' dep_W = 0$. Rearranging the terms and using assumptions, we obtain $\frac{dp}{dep_W} = \frac{q'}{(2q' + (p - ep_W)q'')} \geq 0$. We note that the value of $\frac{dp}{dep_W}$ does not exceed one.

Since the derived demand is a function of wholesale price denominated in the foreign currency, its first derivative is $\bar{q}' = q'\frac{dp}{dep_W} < 0$. This proves the first part. We remain to prove the last part; the second derivative of the derived demand is non-positive. Since $\bar{q}'' = \frac{\partial \bar{q}'}{\partial ep_W} = \frac{\partial\left(q'\frac{dp}{dep_w}\right)}{\partial ep_W} = q''\left(\frac{\partial p}{\partial ep_W}\right)^2 + q'\frac{\partial^2 p}{\partial ep_W^2}$, it is sufficient for the non-positivity of $\bar{q}''$ to show the second derivative of price with respect to the wholesale price denominated in the foreign currency is non-negative.

$$\frac{\partial^2 p}{\partial ep_W^2} = \frac{q''}{\{(p - ep_W)q'' + 2q'\}}\frac{\partial p}{\partial ep_W} - \frac{q'}{\{(p - ep_W)q'' + 2q'\}^2}[\{(p - ep_W)q''' + q'' + 2q''\}\frac{\partial p}{\partial ep_W} - q'']$$

$$= \frac{1}{\{(p - ep_W)q'' + 2q'\}^2}\left[q'q''(1 - \frac{\partial p}{\partial ep_W}) + \frac{\partial p}{\partial ep_W}[(p - ep_W)\{(q'')^2 - q'q'''\}]\right]$$

With assumption 2, it is non-negative, therefore, we proved the last part.   *Q.E.D.*

<u>Proof of Proposition 1</u>

We first specify a linear demand function as q = d - p with profit functions in (1).

[independent firms] From the first order conditions of maximizing profits independently, we obtain $p = \frac{ep_W + d}{2}$, $ep_w = \frac{ec + d}{2}$. The exchange rate pass-through elasticities in three forms are, $\varepsilon^W = \frac{dep_W}{de}\frac{e}{ep_W} = \frac{ec}{ec + d}$, $\eta = \frac{dp}{dep_W}\frac{ep_W}{p} = \frac{ec + d}{ec + 3d}$ *and* $\varepsilon^C = \frac{dp}{de}\frac{e}{p} = \frac{ec}{ec + 3d}$.

[vertically integrated firms] The first order condition leads to $p = \frac{ec + d}{2}$. The exchange rate pass-through elasticity of consumer price is $\varepsilon^C = \frac{dp}{de}\frac{e}{p} = \frac{ec}{ec + d}$.

[other vertical structures]   We use the above result and Table 1.

Figure 1: Exchange rate pass-through at different stages

Exchange rate pass-through on consumer price (ε^C)

Exchange rate pass-through on wholesale price (ε^W)

Whole sale price pass-through on consumer price (η)

(e, c)

manufacturer

$(p_W ; e, c)$

local distributor

$(p; p_W \ (e, c),e)$

Realizations of cost and exchange rate

A manufacturer sets wholesale price for given cost and exchange rate

A distributor sets a retail price for given wholesale price

$$\varepsilon^C = \eta \cdot \varepsilon^W \quad where \quad \varepsilon^C = \frac{dp}{de}\frac{e}{p}, \quad \varepsilon^W = \frac{dep_W}{de}\frac{e}{ep_W} \quad and \quad \eta = \frac{dp}{dep_W}\frac{ep_W}{p}.$$

Table 1. Exchange rate pass-through with various forms of vertical structure

	Independent firms	Vertically Integrated firms	Resale Price Maintenance	Franchise Fee
$\varepsilon^W = \dfrac{dep^W}{de}\dfrac{e}{ep^W}$	incomplete (**)	[(*) , 1]	Incomplete (*)	Complete
$\eta = \dfrac{dp}{dep^W}\dfrac{ep^W}{p}$	incomplete (***)	[(*) , 1]	Complete	Incomplete (*)
$\varepsilon^C = \dfrac{dp}{de}\dfrac{e}{p}$	incomplete (****)	Incomplete (*)	Incomplete (*)	Incomplete (*)

Note: (*) indicates the values of corresponding cells are the same. "Complete" implies that pass-through is unity and "incomplete" refers to that pass-through is less than one. Since $\varepsilon^C = \eta \cdot \varepsilon^W, and \eta, \varepsilon^W \in [0,1]$, ε^C is always less than or equal to ε^W and η.

Table 2. Exchange rate pass-through with various forms of vertical structure (with a linear demand function)

	Independent firms	Vertically Integrated firms	Resale Price Maintenance	Franchise Fee
$\varepsilon^W = \dfrac{dep^W}{de}\dfrac{e}{ep^W}$	X	[X , 1]	X	1
$\eta = \dfrac{dp}{dep^W}\dfrac{ep^W}{p}$	Y	[X , 1]	1	X
$\varepsilon^C = \dfrac{dp}{de}\dfrac{e}{p}$	Z	X	X	X

Note: Z < Y < X < 1, where $X = \dfrac{ec}{ec+d}$, $Y = \dfrac{ec+d}{ec+3d}$, $Z = \dfrac{ec}{ec+3d}$. (In derivation we used participation constraint, ec-d>0, which implies firms are making positive profit when producing.)

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