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Exchange Rate Pass-Through And The Role Of International Distribution Channels

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Manufacturers selling in foreign markets often do not completely pass on the effects of fluctuations in exchange rates to the trade prices of their products. Our paper addresses this puzzle and studies the effects of the international distribution channel on exchange rate pass-through. We develop an exchange rate pass-through model that takes into account the role of an intermediary between a domestic manufacturer and its consumers in a foreign market. We find that the magnitude of the pass-through depends on the presence of an incentive problem in the distribution channel. When there is no incentive problem, pass-through is complete; however, when there is an incentive problem, pass-through depends on various characteristics of the intermediary and the market setting. Our analysis underscores the importance of considering the role of international distribution channels and suggests directions for further work on exchange rate pass-through.

I. INTRODUCTION

Consider the following stylized scenario: "*A German manufacturer sells his cars in the US market. Let the cost of manufacturing each car be incurred by the manufacturer in German marks, while the final price of the car is in US dollars. Then, the revenues and profits that accrue to the manufacturer depend on the exchange rate. If the exchange rate (in DEM per US $) is favorable, the manufacturer's revenues are higher than if the exchange rate is unfavorable. When the exchange rate is unfavorable, the manufacturer may be motivated to pass on some of that `unfavorableness' through higher prices in US dollars to maintain his stream of revenues.*"

However, observed pricing practices indicate that manufacturers seldom completely pass on the effects of fluctuations in the exchange rate to the buyers in foreign markets. In the literature, this observation has sometimes been termed as the exchange-rate pass-through puzzle (e.g., [4]). Even though researchers have addressed this puzzle both from a broad industry-level (e.g., [3], [5]) and from a more micro-economic (e.g., [6], [7]) perspective, several facets of the puzzle remain unexplored (e.g., [4], [12]). We address one such issue and our purpose here is to examine the impact of international distribution channels on the exchange rate pass-through.

Why is it important to examine the role of international

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distribution channels? First, advocates of competitive strategy have long argued the importance of distribution channels in successful business performance. For instance, the Caterpillar Company became a world leader in large-scale construction equipment due to its effectively managed international distribution channel (see [16] for details). In addition, foreign dealers often play a significant role in the entry strategies employed by multinationals. Note, for instance the growing use of foreign franchisees as a mode of international market entry [17, p. 110]. Finally, after empirically examining both aggregate data on US import prices and industry-specific evidence, Mann [14] finds that pass-through varies from industry to industry. She concludes her analysis by speculating various factors, including newly established distribution networks, which can affect pass-through. In spite of the apparent importance, researchers have not devoted much attention to the study of the distribution channel and its impact on exchange rate pass-through. Our paper takes a step to bridge this gap in the literature.

While several other micro-economic explanations have been proposed in the literature, none has included the impact of distribution channels on the pass-through puzzle. With the advent of multinationals, which primarily contribute to the sale of consumer products across the globe, the presence of international distribution channels at the micro-economic level has rapidly escalated. Manufacturers choose independent dealers because of distance from the target market and cost-effectiveness. Alternatives such as vertical integration and foreign direct investment are more capital-intensive and less reversible respectively compared to independent distribution channels. We therefore choose to study manufacturer-dealer interaction in such international distribution channels.

More specifically, we model the pricing decisions of a manufacturer selling his products in a foreign market. We explicitly consider the role of a channel intermediary (e.g., a dealer, an import jobber, or a retailer) in the foreign market through which the manufacturer sells his products. Often, these foreign dealers undertake marketing efforts (e.g., investing in the dealership, advertising, and promotions) to enhance the demand for the manufacturer's products. Further, since they are independently owned businesses, these dealers frequently differ from the manufacturer in terms of their goals and objectives. This results in the manufacturer bargaining and negotiating with foreign dealers who often have some monopoly power in their own local markets.

Given the market power of the dealer, the manufacturer needs to provide sufficient incentives in a negotiated contract. If such incentives are not provided (for example, protecting the dealer under adverse demand conditions), the dealer can refuse to do business and choose to invest her efforts elsewhere--perhaps contract with another multinational. Or, even if the dealer agrees to do business, she may not put forth sufficient effort in selling the manufacturer's products. Consequently, the foreign dealers need to be suitably motivated and managed by the manufacturer. We illustrate the outcomes from such motivation using a contract with a fixed component (franchise fee) and a variable component (price). This is a typical contract[1] negotiated by manufacturers and dealers across national boundaries especially for consumer products where franchising via a network of dealers is common practice.

It is reasonable to ask why this motivation problem is important in an international distribution channel context. Researchers and practitioners have identified two broad approaches to enhance sales and market shares of a manufacturer (see, for example, [13], [11], or [9]). The first is a "pull-strategy" in which a manufacturer spends a lot of money on advertising and consumer promotion to build up consumer demand. Subsequently, the consumers will ask the retailers for the product, the retailers will ask the dealers and the dealers will ask the manufacturer for the product--when this strategy is effective, the consumers pull the product through the channel. The second is a "push-strategy" in which the manufacturer uses, for instance, trade promotions and sales force to aggressively promote the product to dealers, who then promote aggressively to final consumers--here, the product is being pushed through the channel by the manufacturer. In an international context, where the manufacturer is far from the target market, it is likely to be very expensive to adopt a pull-strategy. Instead, pushing the product through the distribution channel becomes more important. It is for this reason that the international dealer becomes important and motivating such a dealer becomes essential.

When the role of such a dealer is considered and the associated incentive problem addressed, we find that some characteristics of the dealer and the market setting help determine the magnitude of the pass-through. Our analysis reveals that the manufacturer has to balance her desire to completely pass-through the effects of exchange rate fluctuations against the need to motivate the dealer to work on her behalf. Among other things, we find that pass-through depends on the dealer's effectiveness in generating demand for the manufacturer's products. Before developing our model, we discuss the related literature to provide a better perspective on our extension of previous research.

Baldwin [1, 2] noted that fluctuations in the dollar during the 1980s have not been passed through trade prices in the manner predicted by the historical pass-through relationship.[2] Estimates of the pass-through in Hung, Kim and Ohno [8] suggest there are differences in pass-through elasticities across countries. Studies by Marston [15] on Japanese manufacturing and Mann [14] on US companies, indicate that the magnitude of the pass-through varies across industries. Our theoretical model provides a foundation for such empirical findings.

How do changes in the exchange rate affect the foreign market price? Dixit [3] deals with this question from a broad industry level perspective and studies pass-through in the context of entry and exit strategies. Dornbusch [4] investigates how the extent of pass-through depends on the degree of product differentiation, and on the relative number of domestic and foreign firms. Krugman [12] shows that "costly" sales expansion implies import prices will not fall much when the dollar appreciates. Froot and Klemperer [7] study pass-through from exchange rates to import prices when firms' future demand depends on current market shares. Feinberg and Kaplan [5] empirically investigate the effects of actual and expected future exchange rates on pass-through. Fisher [6] shows that market structure and exchange rate regime are important in determining pass-through. The spirit of our analysis is in consonance with this stream of research. We too believe that pass-through is affected by industry characteristics and market imperfections. Our goal is to show that one such imperfection (in the form of an

agency problem) arises when channel intermediaries need to be suitably motivated. For convenience, we summarize the findings of preceding significant theoretical and empirical research in Tables 1 and 2 respectively.

The rest of the paper is organized as follows. The next section develops our basic model and identifies the incentive problem in the interaction between the manufacturer and the foreign dealer. Section 3 further characterizes this interaction by making more specific assumptions. It is in this section that we derive the main points of our paper. In Section 4, we discuss some of the major implications of our analysis. Section 5 concludes the paper and two proofs are given in the Appendix.

II. THE MODEL

A risk neutral domestic manufacturer,[3] M, sells his product in a foreign market through a foreign dealer, D. The sales $\left(q \in R^{+}\right)$ of the manufacturer's product sold in that market is a random variable whose density function, g(.), is parameterized by the price $\left(p \in R^{+}\right)$ charged to customers by the dealer and the level of marketing effort $\left(e \in R^{+}\right)$ put forth by the dealer. The precise manner in which these variables affect the density functions will be defined later in the section.

The realized sales of the dealer in the market are observed by both the manufacturer and the dealer, but only the dealer observes the effort she supplies.[4] Observing the effort supplied by the dealer requires frequent monitoring by the foreign manufacturer which is costly. Prices charged to final customers are observed costlessly by both parties. The density function g(.)is common knowledge. A consequence of these assumptions on observability is that the manufacturer cannot explicitly tie the dealer's compensation to the effort she puts forth. This is important in our model, since the manufacturer has to indirectly motivate (i.e., through the terms of a contract that is not contingent on the dealer's effort) the dealer to put forth the appropriate effort.

We assume that the contract between D and M involves a wholesale price at which M sells his product to D, and a fixed one-time up front fee (e.g., a franchise fee) that D pays to M for selling M's products. Thus, the foreign manufacturer offers a two-part tariff scheme to a domestic dealer in an environment with uncertainty and moral hazard. The uncertainty arises from the eventual exchange rate that determines the value of the fixed fee and wholesale revenue to the manufacturer as well as the eventual size of demand in the domestic market. The eventual exchange rate and the demand in the domestic market are taken to be independent events.[5]

The reason for this independence can be understood as follows: only short-run exchange rate changes would matter at the consumer end of the channel where the exchange rate pass-through has been observed to be near zero. Consumer prices are independent of such short-run exchange rate shocks. Therefore, consumer demand as a function of consumer prices would be independent of the exchange rate changes. Separately, moral hazard emerges from the fact that the dealer can affect (probabilistically) the size of domestic demand through his or her effort (advertising, etc.) and this effort cannot be contracted upon.

The sequence of events in the model are as follows:

(1) The manufacturer announces his wholesale price and fixed fees in terms of the foreign currency.
(2) Based on the manufacturer's announcement, the dealer decides whether to carry the manufacturer's product. If the dealer does not agree to participate, the manufacturer makes zero profits through the dealer, and the dealer makes her reservation level of profits from some alternative employment or business arrangement.
(3) Exchange rates are realized.
(4) If the dealer agrees to participate, then the dealer chooses her final price and effort levels. Sales are then realized and profits are made by M and D.[6]

The sequence of events reflects three important elements. Firstly, the manufacturer sets wholesale prices in anticipation of exchange rate changes. Given floating exchange rates, it would be tremendously expensive for the manufacturers in industrialized markets to change prices with every exchange rate change. The realization of exchange rates therefore refers to medium-run exchange rate changes.[7] It is understandable that manufacturer-dealer contracts be drawn taking into consideration medium-run exchange rate changes. Secondly, the manufacturer moves first but only after taking into account the behavior of the dealer in requiring a reservation level of profits and sufficient incentive to put in the necessary selling effort. Lastly, the sequence of events implies that (i) the dealer faces no exchange rate uncertainty in so much as the wholesale price offered by the manufacturer is denominated in the local currency,[8] and (ii) the dealer chooses the selling price assuming market demand is independent of exchange rate changes.

The dealer is assumed to be risk neutral and her expected profits, π_D, are given by

$$\pi_D = (p - w)E[q] - F - C[e],$$

where E[q] is expected sales, C[q] is the cost of effort to the dealer with $\frac{\partial C[\cdot]}{\partial e}$, and $\frac{\partial^2 C[\cdot]}{\partial e^2} > 0 \ \forall \ e > 0$; w is the manufacturer's wholesale price to the dealer, p is the price charged to consumers by the dealer, and F is a fixed fee paid to the manufacturer M by D, the dealer.[9] The manufacturer's expected profits, π_M, are given by:

$$\pi_M = (wS - c)E[q] + FS,$$

where c is the manufacturer's variable cost of production, and S is the *expected* rate of exchange, given by E[S]. Let HC denote home currency (i.e., the dealer's currency) and FC denote foreign currency (i.e., the manufacturer's currency). The exchange rate s is expressed in FC/HC units. C(.), w, p, and F are all in the dealer's currency or HC units. The manufacturer's variable cost of production, c, is expressed in FC units. We assume that E[sq]=SE[q], or equivalently, that s and q

are independent. Two aspects of this assumption need to be elaborated. First, the presence of foreign competition can imply that demand is affected by exchange rate changes. However, in this paper we steer away from such effects by making the above assumption. Next, prices may be sticky at the consumer level and pass-through to consumer prices can be near zero--this is usually a response to short-run exchange rates. In the literature, pass-through to consumer prices has not been an issue--the puzzle has been with reference to trade prices in the context of medium-run exchange rates. Thus, in our model, the manufacturer sets wholesale price in anticipation of medium-run exchange rates, and this exchange rate distribution is summarized in the expected rate of the exchange, *S*.

For expositional convenience we focus on a simple case in which the output variable, *q*, takes one of two values: $0 < q_L < q_H$. The density function, g(.), now represents the probability that q_H is realized. We assume that g(.) depends only on *p* and *e*, and is twice differentiable in prices and efforts with, $\frac{\partial g}{\partial e} > 0$, $\frac{\partial^2 g}{\partial e^2} < 0$, $\frac{\partial g}{\partial p} < 0$, and $\frac{\partial^2 g}{\partial^2 p} > 0$. In addition, we assume that $\frac{\partial^2 g}{\partial p\,\partial e} > 0$ to indicate a lower (less negative) price sensitivity of demand when dealer effort is higher.[10] Hence, the expected sales of the dealer are:

$$E[q(e,p)] = q_L + g(q_H \mid e,p)(q_H - q_L).$$

With this setup in mind, we begin our analysis by documenting a setting in which the manufacturer can select a fixed fee and a wholesale price such that there are no incentive problems in appropriately motivating the dealer. Formally, the manufacturer solves the following problem:

$$\underset{w,F,e,p}{\text{Max}}\ \pi_M, \quad \text{subject to}$$

$$\pi_D(e(\cdot), p(\cdot)) \geq \pi_0 \qquad \text{(IR)}$$

$$e(w,F), p(w,F) \in \underset{e',p'}{\text{Arg max}}\{\pi_D(e',p')\}\ \forall w, F \in R^+, \qquad \text{(EP)}$$

where the IR constraint ensures that D is on average expected to make at least her reservation level of profits,[11] and the EP constraints take into account the manner in which the dealer selects her price and effort levels. Without loss of generality, we set $\pi_0 = 0$.

Finding 1: *Assume risk-neutral agents, w=c/S, and no incentive problems. The dealer selects price and effort levels to maximize the profits of the entire channel.*

Proof: Consider the dealer's effort selection constraint:

$$(p - w)\frac{\partial E[q]}{\partial e} - \frac{\partial C}{\partial e} = 0 \qquad \text{(i)}$$

Rewriting, we have, $\left(p - \frac{c}{S} + \frac{c}{S} - w \right) \frac{\partial E[q]}{\partial e} - \frac{\partial C}{\partial e} = 0$, or

$$\left(p - \frac{c}{S} \right) \frac{\partial E[q]}{\partial e} - \frac{\partial C}{\partial e} = \left(w - \frac{c}{S} \right) \frac{\partial E[q]}{\partial e}. \quad \text{(ii)}$$

Next, D's price selection constraint provides:

$$E[q] + (p - w) \frac{\partial E[q]}{\partial p} = 0. \quad \text{(iii)}$$

Rearranging (3) we have:

$$E[q] + \left(p - \frac{c}{S} \right) \frac{\partial E[q]}{\partial p} = \left(w - \frac{c}{S} \right) \frac{\partial E[q]}{\partial p} \quad \text{(iv)}$$

From (ii) and (iv) it is clear that setting w=c/S will eliminate any deviation from efficiency--where marginal benefit equals marginal cost. That is, at w=c/S the final prices and efforts satisfy the following efficiency conditions: $E[q] = -\left(p - \frac{c}{S} \right) \frac{\partial E[q]}{\partial p}$; and $\left(p - \frac{c}{S} \right) \frac{\partial E[q]}{\partial e} = \frac{\partial C}{\partial e}$. Q.E.D.

By selling the product at his marginal cost, the manufacturer is making his dealer a residual claimant. Consequently, the dealer's objectives at the margin are completely in line with those of the manufacturer. Of course, the manufacturer extracts all rents through the fixed fees, and restricts the expected profits of the dealer to her reservation level. This standard result will prove to be useful in our paper. To summarize the implications of our analysis, we provide the following definition.

Definition: Exchange rate pass-through elasticity, ε, is defined as the negative of the proportionate rate of change of the wholesale price, *w*, divided by the proportionate rate of change of the expected exchange rate, *S*, with all other parameters being constant.

That is, $\varepsilon = -\frac{\partial w / w}{\partial S / S} = -\frac{S}{w} \frac{\partial w}{\partial S}$.

Proposition 1: *In the absence of any incentive problems in the distribution channel, exchange rate pass-through is complete.*

Proof: Compute the pass-through elasticity for *w*, from Finding 1. It is exactly equal to 1. Q.E.D.

In the above set up, the manufacturer succeeded in aligning the dealer's objectives by selling at marginal cost, and transferred all the demand risk to the dealer by a suitable choice of the fixed fee. The magnitude of this fixed fee was such that D received her reservation level of profits (normalized to zero) in *expectation.* This implies that if the realized demand is q_H, D makes positive economic profits, while if the realized demand is q_L, D will incur losses. In reality, however, dealers are often unwilling[12] to bear the entire loss under adverse demand conditions. In fact, the dealer may not agree to do business with the manufacturer if the terms of the contract do not place a ceiling on the magnitude of such losses.

When confronted by such a liability limit or limit on the magnitude of losses, the manufacturer can no longer set the fixed fee as high as he deems fit. In addition, he may no longer find it optimal to sell to the dealer at marginal cost. Consequently, D's objectives will not be perfectly aligned with those of M, and there will be a need to motivate the dealer to put forth appropriate effort levels. We now need to study the new equilibrium contract between M and D to characterize the manner in which the manufacturer selects the wholesale price, and subsequently, the magnitude of exchange rate pass-through.

Before characterizing the new equilibrium, the following point should be noted. The manufacturer now needs to design his (w, F) contract so that the dealer's losses under adverse demand conditions, i.e., when q_L is realized, are not greater than a prespecified level. Without loss of generality, we set this prespecified level to be zero--i.e., D is now assured at least zero economic profits when q_L is realized. Now, the manufacturer's problem is:

$$\underset{w,F,e,p}{\text{Max}}\ \pi_M, \quad \text{subject to}$$

$$(p - w)q_L - F - C[e] \geq 0 \qquad \text{(MP)}$$

$$e(w, F),\ p(w, F) \in \underset{e', p'}{\text{Arg max}}\ \{\pi_D(e', p')\} \forall\ w, F \in R^+, \qquad \text{(EP)}$$

where, the MP constraint ensures that D does not incur losses under adverse demand conditions. As before, the EP constraints take into account the manner in which the dealer selects her price and effort levels. A solution to the manufacturer's problem has the following properties:

Finding 2: *Here, the manufacturer will design a contract such that* $(p - w)q_L - F - C[e] = 0$*; that is, the dealer is restricted to exactly zero economic profits when the realized state of nature is* q_L*. For other realizations of q, the dealer makes positive profits.*

Final price and effort levels chosen by the dealer will be inefficient from the channel perspective. That is, the marginal cost of each of these variables will be less than the marginal revenue to the channel.

Proof: The Lagrangian is:

$$\begin{aligned} L = {} & (wS - c)E[q] + FS \\ & + \lambda \{(p - w)q_L - F - C(e)\} \\ & + \mu_e \left\{ (p - w)\frac{\partial E[q]}{\partial e} - \frac{\partial C}{\partial e} \right\} \\ & + \mu_p \left\{ E[q] + (p - w)\frac{\partial E[q]}{\partial p} \right\}. \end{aligned}$$

Kuhn-Tucker (KT) analysis:

$$\frac{\partial L}{\partial F} = S - \lambda = 0 \qquad \text{(i')}$$
$$\Rightarrow \lambda = S$$

Next, we have using (i'):

$$\frac{\partial L}{\partial w} = S\left(E[q] - q_L\right) - \mu_e\left(\frac{\partial E[q]}{\partial e}\right) - \mu_p\left(\frac{\partial E[q]}{\partial p}\right) = 0.$$

We can rewrite the above expression as:

$$S\left(E[q] - q_L\right) = \mu_e\left(\frac{\partial E[q]}{\partial e}\right) + \mu_p\left(\frac{\partial E[q]}{\partial p}\right) . \qquad \text{(ii')}$$

Since LHS in the above equation is non-negative, it follows that the sum of all the terms on the RHS need to be non-negative. This suggests that the Lagrange multipliers, μ_e and μ_p, are both not zero. Keeping this in mind, consider the KT conditions below:

$$\frac{\partial L}{\partial e} = (wS - c)\frac{\partial E[q]}{\partial e} + S\left\{-\frac{\partial C}{\partial e}\right\} + \mu_e\left\{(p - w)\frac{\partial^2 E[q]}{\partial e^2} - \frac{\partial^2 C}{\partial e^2}\right\}$$
$$+ \mu_p\left\{\frac{\partial E[q]}{\partial e} + (p - w)\frac{\partial^2 E[q]}{\partial e\,\partial p}\right\} = 0.$$

We can rewrite the above as:

$$\mu_e\left\{(p - w)\frac{\partial^2 E[q]}{\partial e^2} - \frac{\partial^2 C}{\partial e^2}\right\} + \mu_p\left\{\frac{\partial E[q]}{\partial e} + (p - w)\frac{\partial^2 E[q]}{\partial e\,\partial p}\right\} \qquad \text{(iii')}$$
$$= S\left\{\frac{\partial C}{\partial e}\right\} - (wS - c)\frac{\partial E[q]}{\partial e}$$

And,

$$\frac{\partial L}{\partial p} = (wS - c)\frac{\partial E[q]}{\partial p} + S\{q_L\} + \mu_e\left\{\frac{\partial E[q]}{\partial e} + (p - w)\frac{\partial^2 E[q]}{\partial p\,\partial e}\right\}$$
$$+ \mu_p\left\{2\frac{\partial E[q]}{\partial p} + (p - w)\frac{\partial^2 E[q]}{\partial p^2}\right\} = 0.$$

We can rewrite as:

$$\mu_e\left\{\frac{\partial E[q]}{\partial e} + (p - w)\frac{\partial^2 E[q]}{\partial p\,\partial e}\right\} + \mu_p\left\{2\frac{\partial E[q]}{\partial p} + (p - w)\frac{\partial^2 E[q]}{\partial p^2}\right\} \qquad \text{(iv')}$$
$$= -\left((wS - c)\frac{\partial E[q]}{\partial p} + Sq_L\right).$$

Examining the coefficients of μ_e and μ_p in (iii') and (iv') along with the assumptions on how $g(.)$ varies with *e* and *p*, and using Kramer's rule we can see that both these multipliers will be non-zero. Q.E.D.

In the above analysis, we introduced the "incentive" problem through the limited loss constraint (or MP constraints) that the manufacturer has to contend with in designing his contract. Another obvious manner in which the incentive

problem may be introduced is through dealer risk aversion. When the dealer is risk averse, M cannot transfer all the demand risk to D, and once again there will be a need to motivate the dealer through an appropriate (w, F) contract. While there are a number of ways of introducing the incentive problem, the important point to note is that irrespective of the manner in which it is introduced, the incentive problem in distribution channels will affect the international trade prices of multinational manufacturers.

Finding 2 essentially indicates the presence of one incentive problem that the manufacturer has to balance against in selecting his wholesale price. Our assertion in this paper is that, it is this balancing that forces the magnitude of the pass-through to vary in different market settings. The "general" structure of the above model does not allow us to demonstrate the link with pass-through. In the next section, though, we elaborate on the link between exchange rate pass-through and the incentive problem by making more specific assumptions about demand in the foreign market and the dealer's costs of effort.

III. FURTHER CHARACTERIZATION

In this section, we assume that the demand, q, for M's product in the foreign market is given by, $q = N - p$, where N defines the size of the market. However, N is assumed to be a random variable that can take one of two values:[13] $0<N_L<N_H$. The density function, g(.), now represents the probability that N_H is realized. We simplify the model by assuming that this probability is parameterized only by D's effort. In the earlier section, the probability was parameterized by both price and effort representing a nonlinear demand model where the higher the price, the less probable is the high demand state and vice versa. The simplification in this section represents a linear demand model but does not result in any loss of generality. In both cases, the price elasticity of demand varies at different price levels. The following notation is used to denote *expected* size of the market:

$$N(e) = N_L + g(N_H \mid e)\ (N_H - N_L),$$

Further, we assume $g(N_H \mid e) = Ae$, where $A > 0, \forall e > 0$ and the magnitude of A is such that g(.)<1 when e belongs to a compact set, the upper limit of which is less than infinity. We define $k=A[N_H-N_L]$, normalize its value to belong to the open interval (0,1), and refer to it as the dealer's effectiveness parameter. *Expected* sales are now given by:

$$E[q] = (N(e) - p) = N_L + ke - p\ .$$

As before, the dealer is assumed to be risk neutral, and her expected profits, π_D, are given by

$$\pi_D = (p - w)E[q] - F - C(e),$$

where $C[\cdot]$ is the cost of effort to the dealer with C[e]=e^2/2; w is M's wholesale price to D, p is the price charged to consumers by D, and F is the franchise fee paid to M by D. As in the previous section, M's expected profits, π_M, are given by:

$$\pi_M = (wS - c)E[q] + FS,$$

where c is the variable cost of production and S is the *expected* rate of exchange. As before, we assume that s and q are independent of each other; i.e., E[sq]=SE[q]. A formal statement of the manufacturer's problem when dealer effort is unobservable can now be written:

$$\underset{w,F,e,p}{\text{Max}}\ (wS - c)E[q] + FS, \quad \text{subject to}$$

$$\pi_D(e(\cdot), p(\cdot)) \geq \pi_0, \tag{IR}$$

$$e(w,F), p(w,F) \in \underset{e,p}{\text{Arg max}}\ \{\pi_D(e', p')\} \forall\, w, F \in R^+ \tag{EP}$$

The IR constraint ensures that D makes at least her reservation level of expected profits; the EP constraint reflects the manner in which D selects her price and effort levels. A solution to this problem is described below:

Finding 3: *At optimality,*

$$w = \frac{c}{S};\ \textit{and}\ F = \frac{(N_L S - c)^2}{(4 - 2k^2)S^2} \tag{1}$$

$$p = \frac{N_L S + (1 - k^2)c}{(2 - k^2)S};\ \textit{and}\ e = \frac{k(N_L S - c)}{(2 - k^2)S}. \tag{2}$$

$$E[q] = \frac{N_L S - c}{(2 - k^2)S}, \tag{3}$$

$$\pi_M = \frac{(N_L S - c)^2}{(4 - 2k^2)S},\ \textit{and}\ \pi_D = 0. \tag{4}$$

Proof: See the Appendix.

Findings 3(1) and 3(4) indicate that the manufacturer will sell the product at cost, and extract all of the dealer's surplus through the franchise fee--of course, both w and F are appropriately modified by the expected exchange rate. Finding 3(2) indicates that the price charged to consumers increases as the dealer becomes more effective, and the effort level put forth by the dealer increases with effectiveness. Both the final price and effort are functions of the expected exchange rate. Findings 3(3) and 3(4) indicate that the expected quantity sold and the manufacturer's expected profits will increase with the dealer's effectiveness.

It should be noted that the manufacturer's optimal wholesale price decreases as the expected exchange rate increases or as the foreign currency strengthens; the franchise fee, on the other hand increases with expected exchange rate. It appears that when the exchange rate is likely to be favorable to the manufacturer, he reduces the unit cost to D while extracting the dealer's surplus through the fixed fee.

Next, the final price to the consumer and the dealer's effort level increases with the expected exchange rate. Both these result from the decline in the manufacturer's wholesale price with increasing exchange rates. If the expected exchange rate is higher, the dealer is charged a lower wholesale price and is thus motivated to sell more. As a consequence, the dealer works harder, but such added effort is costly. Such a higher marketing cost means an increase in *fixed* costs for the dealer. This higher level of fixed costs does not affect the optimal price level. In fact, the price increase is because of the outward shift of the demand curve caused by a higher level of marketing efforts. The dealer, therefore, optimally charges a higher final price.[14] The expected quantity sold increases with exchange rate and manufacturer's expected profits increase with expected exchange rates. As in Proposition 1, the pass-through elasticity can be seen to be 1.

Recalling the discussion before Finding 2, we now solve the manufacturer's problem when there is a prespecified ceiling to the losses borne by the dealer when $N=N_L$. Without loss of generality, we set this ceiling to be zero, and M's problem is stated below:

$$\underset{w,F,e,p}{\text{Max}}\ \pi_M, \quad \text{subject to}$$

$$(p-w)\ (N_L - p) - F - C[e] \geq 0 \qquad \text{(MP)}$$

$$e(w,F),\ p(w,F) \in \underset{e,p}{\text{Arg max}}\ \{\pi_D(e',p')\}\ \forall\ w, F \in R^+ \qquad \text{(EP)}$$

The MP constraint ensures that the dealer makes at least zero level profits under the low demand condition. A solution to this problem has the following properties.

Finding 4: *At optimality,*

$$w = \frac{2k^2 N_L S + (2-k^2)c}{(2+k^2)S};\ \textit{and}\ \ F = \frac{(2-3k^2)(N_L S - c)^2}{2S^2(2+k^2)^2} \qquad (1)'$$

$$p = \frac{(1+2k^2)N_L S + (1-k^2)c}{(2+k^2)S};\ \textit{and}\ \ e = \frac{k(N_L S - c)}{(2+k^2)S} \qquad .(2)'$$

$$E[q] = \frac{N_L S - c}{(2+k^2)S}; \qquad (3)'$$

$$\pi_M = \frac{(N_L S - c)^2}{2S(2+k^2)},\ \textit{and}\ \ \pi_D = \frac{k^2(N_L S - c)^2}{S^2(2+k^2)^2}; \qquad (4)'$$

$$\textit{When } N = N_L\textit{, dealer's economic profits = 0.} \qquad (5)'$$

Proof: See the Appendix.

It is worth reiterating here that the above analysis has been conducted in *expectation.* The optimal dealer's effort in 4(2') does not guarantee the size of the market. Irrespective of the amount of effort that is put forth by the dealer, the size of the market, *N*, can be realized as either N_L or N_H. It is only the probability that N_H is realized that increases with the dealer's effort. And the manufacturer's contract is intended to motivate higher effort levels. Keeping this in mind, we now discuss the above results.

Finding 4(1') indicates that the manufacturer sets w>c/s, whenever $c<N_LS$, and w increases as k increases. F decreases with dealer effectiveness, k, and when k is sufficiently large (i.e., $k^2>2/3$), F is negative. Note that a negative F implies that the manufacturer pays the dealer a fixed fee to carry his products, while a positive F implies that the fee is paid by the dealer. Finding 4(2') indicates that the dealer's effort increases with effectiveness; however, dealer's prices to final consumers also increase with effectiveness. The net result is reflected in 4(3'), which shows that expected sales decrease with dealer effectiveness. That is, the more effective dealer is selling fewer units, but at higher prices. Finding 4(5') shows that the dealer's MP constraint is binding--the manufacturer ensures that the dealer makes exactly zero profits when the worst state of nature is realized. Consequently, the dealer makes positive expected profits as shown in Finding 4(4'). Further, finding 4(4') indicates that the manufacturer's expected profits decrease with dealer's effectiveness, while the dealer's profits increase with effectiveness.

As in Finding 3, the manufacturer's optimal wholesale price decreases with the expected exchange rate; however, the rate of decrease is different and depends on the dealer's effectiveness. For small values of k, the fixed fee F increases with expected exchange rate, S; but for larger values of k, F decreases with S. Dealer's effort increases with S, but final prices to consumers decrease with S. As a result, expected sales increase with exchange rate. Finally, both the manufacturer's and the dealer's expected profits increase with the expected exchange rate.

Based on the above characterization of the equilibrium, we can derive the following implications.

Proposition 2: *If the MP constraints are binding, then the exchange rate pass-through is incomplete.*

Proof:
The pass-through elasticity for the optimal wholesale price derived in Finding 4 is: $\varepsilon = (2-k^2)c/[(2-k^2)c+2kN_LS]$. Notice that the denominator is always positive in the relevant range of the parameters, i.e., $0<k<1$. Consequently, the elasticity is less than one, and exchange rate pass-through is incomplete. Q.E.D.

Notice that in the above scenario, when the manufacturer has to motivate the dealer to work on his behalf, pass-through is never complete. If the manufacturer attempts to attain complete pass-through, the dealer will put forth inefficient levels of effort. On the other hand, if the manufacturer attempts to motivate the dealer, pass-through is incomplete. Consequently, the equilibrium pass-through represents the manufacturer's optimal compromise between following the exchange rate fluctuations to enhance his profit stream, and not allowing sufficient pass-through to motivate the dealer to work hard on his behalf. It is interesting to note how pass-through varies with the parameters of the market setting.

Proposition 3: *When the MP constraints are binding, the optimal pass-through has the following properties:*

(a) Pass-through decreases with dealer's effectiveness, k;

(b) Pass-through decreases with the maximum size of the market under adverse demand condtions, i.e., $N = N_L$;

(c) Pass-through increases with the manufacturer's marginal cost of production, c; and,

(d) Pass-through decreases with the magnitude of the expected rate of exchange.

Proof:

Computing the appropriate derivatives of the elasticity gives:

$$\frac{\partial \varepsilon}{\partial k} = \frac{-8kcN_L S}{\left[\left(2-k^2\right)c + 2k^2 N_L S\right]^2} < 0 \cdot \quad \text{(a)}$$

$$\frac{\partial \varepsilon}{\partial N_L} = \frac{-2k^2 c\left(2-k^2\right)S}{\left[\left(2-k^2\right)c + 2k^2 N_L S\right]^2} < 0 \cdot \quad \text{(b)}$$

$$\frac{\partial \varepsilon}{\partial c} = \frac{2k^2 N_L\left(2-k^2\right)S}{\left[\left(2-k^2\right)c + 2k^2 N_L S\right]^2} > 0 \cdot \quad \text{(c)}$$

$$\frac{\partial \varepsilon}{\partial S} = \frac{-2k^2 cN_L\left(2-k^2\right)}{\left[\left(2-k^2\right)c + 2k^2 N_L S\right]^2} < 0 \cdot \quad \text{Q.E.D.} \quad \text{(d)}$$

Property (a) indicates that as the dealer becomes more effective, it is more important for the manufacturer to provide appropriate incentives to the dealer than to follow the exchange rate. Property (b) suggests that as the severity of the adverse demand conditions decreases (i.e., N_L increases), pass-through decreases. As N_L increases the dealer needs to be given more profits to participate with the manufacturer; as a consequence, the dealer is more motivated to engage in discretionary behavior. In order to provide such a dealer with the appropriate incentives, the manufacturer decreases the amount of pass-through.

Property (c) indicates the supply-side effects on pass-through. The manufacturer's desire to follow the exchange rate and achieve complete pass-through increases with the cost of manufacturing. With higher costs, the manufacturer is more concerned with making sufficient profits than with motivating the dealer. Finally, property (d) suggests that as the exchange rate becomes more favorable, the manufacturer makes sufficient profits and is less inclined to follow exchange rate fluctuations. Instead, the manufacturer attempts to motivate the dealer to work harder.

In addition to these results on pass-through, our analysis reveals some noteworthy features of the manufacturer-dealer interaction. We find that when the MP constraint binds, the wholesale price is invariant to the effectiveness of the dealer when the size of the market under adverse demand conditions (i.e., N_L) translated to the manufacturer's currency is equal to the marginal cost of the manufacturer. At all other times, the wholesale price does change with the effectiveness of the dealer. It is also interesting to note the direction of payment of the franchise fee. As the dealer becomes more effective in enhancing the demand for the product in her local market, the manufacturer has to pay the dealer some franchise fee rather than the other way around.[15]

IV. DISCUSSION

We begin this section by offering some implications of our analysis to pass-through elasticities for various product categories. Subsequently, we will provide data on pass-through elasticities from the Bureau of Labor Statistics to support our implications. We realize that this is not a rigorous empirical test of our model. However, we want to show that anecdotal evidence is consistent with the predictions of our model.

Consider products that are imported into the US market. In general, the market is large and more competitive with a larger number of suppliers.[16] Foreign manufacturers therefore need to adjust their export prices to provide sufficient incentive to the dealers to carry their product as well as to maximize profits. As we have seen in the previous section, apart from the size of the market, the effectiveness of the dealer and the marginal cost of the manufacturer would be additional factors determining their export prices and the resulting exchange rate pass-through. Since it is important for the foreign manufacturer to provide sufficient incentive to the dealer, we would expect pass-through to be incomplete for US imports.

Now consider foreign markets to where the US manufacturers export. Due to homogeneity of preferences, many foreign consumers seek US products. If foreign dealers are more willing to bear the demand risk associated with carrying US products, the US manufacturer does not need to motivate the foreign dealer in selling the product. Their pricing policy reflects this difference and pass-through is likely to be complete (i.e., pass-through elasticity is close to one) when US manufacturers export their products via foreign dealers.

Interestingly, even though the above discussion characterizes the general trends we hope to find in pass-through elasticities, there are likely to be product categories in which (a) foreign manufacturers do not face significant competition in the US market, and (b) US manufacturers face a competitive environment in foreign markets. In (a), we expect to find pass-through elasticities for US imports close to one; and in (b), we expect to find pass-through elasticities for US exports much less than one.

Before presenting the data, consider an alternative hypothesis from Hung, Kim and Ohno [8, p. 22]. (Note that the findings of Hung, Kim and Ohno are argued to be consistent with the research of Krugman [12], Marston [15], Knetter [10], and others.) In their paper, Hung-Kim-Ohno find that the export prices of US products are not affected by exchange rate fluctuations; they argue that the US is a relatively large and closed economy and that export prices are mainly influenced by domestic cost changes and not by exchange rate changes. In contrast, the implications of our model suggest that export prices should exhibit complete pass-through since we consider the role of intermediaries.

The above argument suggests that the implications of our analysis are not trivial. Firstly, our predictions directly oppose those developed in previous research. More importantly, our predictions suggest that considering the role of intermediaries is essential in gaining a complete understanding of exchange rate pass-through. With these implications in mind, let us consider the data from the Bureau of Labor Statistics in Tables 3 and 4.

During the period 1980-1991, the trade-weighted dollar steadily appreciated during the first half and then steadily depreciated to its initial value in the latter half [see Figure 1]. We could assume given these long swings in the dollar that expectations about future exchange rates would have evened out over this period and would not affect estimates of exchange rate pass-through based on the 1980-1991 data. The following points may be noted based on Tables 3 and 4:

(1) In general, US import prices - i.e., prices when foreign manufacturers sell through US intermediaries - exhibit pass-through elasticities less than one.

(2) In general, US export prices - i.e., prices when US manufacturers sell through foreign intermediaries - exhibit pass-through elasticities close to one.

However, (3a) there are product categories in which import prices show pass-through elasticities close to one; and (3b) there are product categories in which export prices have pass-through elasticities much less than one. Note that the product categories in (3a) and (3b) are an exception rather than the rule. Therefore, the data supports our implications to a certain degree. The anecdotal evidence supports our primary thesis that motivating intermediaries is a key factor in explaining pass-through elasticities. To test our theory, we would need to show that such differences in pass-through elasticities between exports and imports across product categories can be predicted using the predictive factors in our model. These predictive factors are maximum size of the market during bad states of the world, dealer effectiveness, manufacturer's marginal cost of production, and expected exchange rates.

We will conclude this section with a final point about our model. In our analysis, we introduced the "incentive" problem through the limited loss or minimum profit constraint (MP constraints) that the manufacturer has to contend with in designing his contract. Another obvious manner in which this incentive problem may be introduced is through dealer risk aversion. When the dealer is risk averse, the manufacturer cannot transfer all the demand risk[17] to the dealer, and once again there will be a need to motivate the dealer through an appropriate (w, F) contract. While there are a number of ways of introducing the incentive problem, the important point to note is that irrespective of the manner in which it is introduced, the incentive problem in distribution channels will affect the international trade prices of multinational manufacturers. Finding 2 essentially indicates the presence of one incentive problem that the manufacturer has to balance against in selecting his wholesale price. Our assertion in this paper is that, it is this balancing that forces the magnitude of the pass-through to vary in different market settings.

Table 3
Import Exchange Rate Changes And Pass-Through Estimates

The second international BLS series used in this analysis is the trade-weighted exchange rate index series. This series used bilateral U.S. trade weights to construct a separate exchange rate for each detailed level of import and export price indexes. The basic imperfect substitutes model pass-through rates is $\Delta PM_i = f(\Delta ER_i, C_i)$, where PM_i is import price of good *i,* ER_i is the trade-weighted exchange rate for good *i*, and C_i is the monotonic trend for changes in the price of good *i.* The actual equation used for estimating the pass-through rate for U.S. import prices used the following formula:
where *PM* is the import (export) price index in quarter *t*, *ER* is the trade-weighted average

$$\Delta \ln PM_{t,i} = \alpha_i + \sum_{j=0}^{5} Bx_{j,i} \Delta \ln ER_{t-i,j} + \mu_{t,i}$$

exchange rate in quarter *t* (and 5 lag periods) for group *i.* The sum of the 6 estimated *Bx* coefficients is equal to the pass-through rate. The product categories here are representative of a larger set of 58 product categories.

Table 4
Export Exchange Rate Changes And Pass-Through Estimates

The second international BLS series used in this analysis is the trade-weighted exchange rate index series. This series used bilateral U.S. trade weights to construct a separate exchange rate for each detailed level of import and export price indexes. The basic imperfect substitutes model pass-through rate is $\Delta PM_i = f(\Delta ER_i, C_i)$, where PM_i is import price of good *i*, ER_i is the trade-weighted exchange rate for good *i*, and C_i is the monotonic trend for changes in the price of good *i*. The actual equation used for estimating the pass-through rate for U.S. import prices used the following formula:

$$\Delta \ln PM_{t,i} = \alpha_i + \sum Bx_{j,i} \Delta \ln ER_{t-j,i} + u_{t,i}$$

where *PM* is the import (export) price index in quarter *t*, *ER* is the trade-weighted average exchange rate in quarter *t* (and 5 lag periods) for group *i*. The sum of the 6 estimated *Bx* coefficients is equal to the pass-through rate. The product categories here are representative of a larger set of 58 product categories.

Figure 1
FRB Atlanta Dollar Index: 1980 - 1991

The Federal Reserve Bank of Atlanta index is based on 1984 bilateral trade weights for 18 currencies. The European subindex includes Belgium, France, Germany, Italy, the Netherlands, Spain, Sweden, Switzerland, and the United Kingdom. The Pacific group includes Australia, China, Hong Kong, Japan, Singapore, South Korea, and Taiwan. The Canadian dollar is treated as a separate subindex, and the overall dollar index includes the Saudi Arabian riyal along with the foregoing 17 currencies. A rise in the index or subindex reflects a strengthening of the dollar against currencies included.

V. CONCLUSION

We have studied exchange rate pass-through in a setting where the dealer's choices of marketing effort and final prices to consumers cannot be directly controlled by a multinational manufacturer. The focus of our inquiry has been on the impact of the dealer on pass-through. It is clear from our analysis that the distribution sector can go a long way toward explaining the incomplete exchange rate pass-through that is seen to vary from country to country, from industry to industry within a country, and from company to company, within an industry. Some of this observed variation is likely to be due to the varying characteristics of the distribution sector (the

distribution network may be newly established, the dealers are very effective, etc.) We note, however, that the presence of a distribution sector by itself will not affect pass-through Rather, it is the presence of an incentive problem in the distribution sector that leads to incomplete pass-through. In general, pass-through depends on the characteristics of the dealer, and the market setting, along with the nature of the manufacturer-dealer contract.

Providing the dealer with the appropriate incentives to work on behalf of the manufacturer is the linchpin in our explanation of the pass-through puzzle. The manufacturer has to tradeoff some of the exchange rate pass-through to ensure that the dealer will work hard in expanding the market. In particular, when the dealer needs to be protected against adverse demand conditions--either due to limited liability constraints or risk aversion--the manufacturer cannot allow his wholesale price to reflect all the effects of the fluctuations in the exchange rate. The resulting reduction in pass-through is found to depend on the level of effectiveness of the dealer. In addition, the magnitude of the pass-through depends both on the demand conditions in the foreign market and the cost parameters of the manufacturer.

Our analysis was couched in the framework of a simple model, but, preliminary analysis indicates that our results are likely to hold in more general settings. We focused primarily on franchise fee contracts because of their apparent simplicity and wide usage (see, for example, [17]). However, there are likely to be other contracts utilized by multinationals; for instance, the manufacturer may offer a baseline regular wholesale price, and discount the regular wholesale price based on sales performance of the dealer. In this paper, we do not attempt to determine which of these multitudes of contracts is *the* optimal contract.

Further, our analysis is conducted in the context of a one manufacturer - one dealer scenario, without explicitly considering the effects of competition. We confine our analysis to a one-period setting and the manufacturer in our analysis takes all the risk due to exchange rate uncertainty. Finally, our emphasis has been on exchange rate distributions rather than on exchange rate realizations. Our purpose in this paper has been to highlight the main issues, with a simple model that takes into account the role of a dealer. We realize that some of the factors discussed above are important, and we intend to address them in our future research. One additional direction for future research is to study if pass-through is greater in countries where capital is plentiful (or limited liability laws are weak) as predicted by our analysis.

Our analysis adds to the Froot and Klemperer [7] study of exchange-rate pass-through when market share matters. They investigate the pass-through from exchange rates to import prices when firms' future demands depend on current market shares.They conclude that import prices may be more sensitive to expected future than to current exchange rates. In our analysis, firms' future demands depend on the price as well as the distribution effort of the dealer and the effectiveness of the dealer. These have been traditionally accepted as determinants of current market shares. While Froot and Klemperer [7] focus on prices and competition as determinants of current market share, we concentrate on the distribution sector and the impact of incentives in the distribution channel on the exchange rate pass-through. Thus, we show that in building current market share for future profit maximization, if intermediaries need to be incentivized, this can be one reason,

among others, that results in incomplete exchange rate pass-through. In this sense, our analysis of exchange rate pass-through complements Froot and Klemperer's [7] market share based explanation.

In summary, multinationals can enhance business performance through improved coordination of their distribution channels. Clearly, such improved coordination is contingent on unraveling the exchange rate pass-through puzzle. However, unraveling this puzzle is contingent on understanding several issues, some of which have been discussed in this paper. We hope our analysis will spark more research on the role of the distribution sector in international business, and on exchange rate pass-through.

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NOTES

1. This is not an optimal contract. Because of asymmetric information and the inability to directly monitor the agent, the principal cannot infer the actions of the agent and must derive a second-best contract. The main focus of our analysis is to study the impact of such commonly used contracts on exchange rate pass-through. We, therefore, do not pursue optimal contract design.
2. That is, the relationship between exchange rates and prices prior to 1973 when exchange rate movements were controlled (i.e. the fixed exchange rate regime), and during the 1973-1980 period when there were no large fluctuations in the US dollar (i.e., the floating exchange rate regime). For comparison, see Figure 1, which shows the fluctuations in the trade-weighted dollar from 1980 onwards - the data for the graph, is provided by the Federal Reserve Bank of Atlanta.
3. Please note that in the rest of the paper, we use manufacturer to mean any supplier, and a dealer to mean any distributor, or agent.
4. By "observable" we mean "costlessly observable." Technically, each of the relevant variables is potentially observable; however, the cost of observation can be prohibitively expensive--that is what we mean by "unobservable."
5. The independence assumption can be interpreted as absence of foreign competition in the local market. If so, exchange rate changes do not result

in price elasticity of demand effects in the local market. Thus, the cashflows of the dealer are not sensitive to exchange rate changes. In other words, the dealer does not have any economic exposure due to exchange rate changes.

6. It may be noted that the sequence of events in our model parallels the sequence in Fisher [6], where an industry level analysis is conducted.
7. The exchange rate pass-through puzzle applies to medium-run exchange rate changes and their impact on wholesale prices. As mentioned earlier, short-run exchange rate changes would matter only at the consumer end of the channel where it is not surprising that the exchange rate pass-through is near zero.
8. Hung, Kim and Ohno [8] mention that the US$ is widely used in invoicing. Even non-U.S. exporters use the US$ for exports to the USA. We will illustrate later that our assumptions and results explain observed exchange rate pass-through for US imports and exports.
9. We assume that w and F are denominated in the foreign currency, implying that the currency risk is borne entirely by the manufacturer. Empirically, exports to the US are usually observed to be invoiced in dollars, and non-US exports are invoiced in domestic currencies (see page 25 in Hung, Kim and Ohno [8]).
10. We thank an anonymous referee for this interpretation of the cross-partial. This assumption is mainly necessary to ensure second order conditions for global profit maximization.
11. That is, by carrying the manufacturer's products, the distributor needs, on average, to make at least her opportunity cost.
12. Often there are bankruptcy laws or limited liability conditions that restrict these losses (see, for example, [18]).
13. Future market demand can be either high or low corresponding to a good or bad state of the market respectively. If a more general multinomial distribution is used, as long as the dealer's profits are non-zero in the worst possible state, our results will hold. Thus the simplification is made without loss of generality.
14. We thank an anonymous referee for providing this economic intuition.
15. Such arrangements are not uncommon. For instance, the Yanase & Company is the strongest import specialist in Japan. It controls most import car sales in Japan and often dictates terms to manufacturers. For an example involving Volkswagen, see Financial World (Sept. 29, 1992, p.24-26).
16. See Hung, Kim and Ohno [8] for a discussion of the reasons for the asymmetric position of US exporters vis-a-vis German and Japanese exporters in dealing with their respective export markets.
17. Recall that exchange risk in our model is being borne by the manufacturer. It is possible that in some instances, the manufacturer pushes the exchange risk onto the foreign firms, say by pricing in a common currency to all international markets. Such a strategy will help when the foreign currency is highly volatile. In this paper, we steer away from such volatility issues to highlight the role of the intermediary.

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APPENDIX

Proofs of Findings 3 and 4 are identical to those in Findings 1 and 2. Here, we substitute the E[q] in Findings 1 and 2 with the expression generated in equation (2) Section 3; also, C[q] is replaced with $e^2/2$.

Proof of Finding 3.

$$\underset{w,F}{\text{Max}}\ \{(wS - c)(N_L + ke - p) + FS\}, \quad \text{subject to}$$

$$\{(p - w)(N_L + ke - p) - F - C[e]\} \geq 0\text{; and,}$$

$$p(w,F), e(w,F) \in \underset{p',e'}{\text{Arg max}}\ \{(p' - w)(N_L + ke' - p') - F - C[e']\}.$$

The Lagrangian for the problem is:

$$\begin{aligned} L = {} & (wS - c)(N_L + ke - p) + FS \\ & + \lambda\left\{(p - w)(N_L + ke - p) - F - \frac{e^2}{2}\right\} \\ & + \mu_p\{(p - w)(-1) + (N_L + ke - p)\} \\ & + \mu_e\{(p - w)(k) - e\}. \end{aligned}$$

Using Kuhn-Tucker analysis, we have:

$$\frac{\partial L}{\partial F} = S - \lambda = 0 \Rightarrow \lambda = S. \tag{A1}$$

$$\frac{\partial L}{\partial w} = -k\mu_e + \mu_p = 0. \tag{A2}$$

$$\frac{\partial L}{\partial e} = -eS - \mu_e + k\mu_p + k(pS - c) = 0. \tag{A3}$$

$$\frac{\partial L}{\partial p} = c + k\mu_e - 2\mu_p + S(N_L + ke) - 2pS = 0. \tag{A4}$$

$$\frac{\partial L}{\partial \mu_p} = (N_L + ke + w - 2p) = 0. \tag{A5}$$

$$\frac{\partial L}{\partial \mu_e} = (p - w)(k) - e = 0. \tag{A6}$$

$$\frac{\partial L}{\partial \lambda} = (p - w)(N_L + ke - p) - F - \frac{e^2}{2} = 0. \tag{A7}$$

Solving the above seven equations simultaneously, we obtain the results in Finding 3.

Proof of Finding 4.

$$\underset{w,F}{\text{Max}}\ \{(wS - c)(N_L + ke - p) + FS\}, \quad \text{subject to}$$

$$\left\{(p - w)(N_L - p) - F - \frac{e^2}{2}\right\} \geq 0 \text{ ; and,}$$

$$p(w,F), e(w,F) \in \underset{p',e'}{\text{Arg max}}\ \{(p' - w)(N_L + ke' - p') - F - C[e']\}.$$

The Lagrangian for the problem is:

$$\begin{aligned} L = {} & (wS - c)(N_L + ke - p) + FS \\ & + \lambda\left\{(p - w)(N_L - p) - F - \frac{e^2}{2}\right\} \\ & + \mu_p\{(p - w)(-1) + (N_L + ke - p)\} \\ & + \mu_e\{(p - w)(k) - e\}. \end{aligned}$$

Using Kuhn-Tucker analysis, we have:

$$\frac{\partial L}{\partial F} = S - \lambda = 0. \quad \Rightarrow \lambda = S. \tag{A8}$$

$$\frac{\partial L}{\partial w} = keS - k\mu_e + \mu_p = 0. \tag{A9}$$

$$\frac{\partial L}{\partial e} = -eS - \mu_e + k\mu_p + k(wS - c) = 0. \tag{A10}$$

$$\frac{\partial L}{\partial p} = c + k\mu_e - 2\mu_p + N_L S - 2pS = 0. \tag{A11}$$

$$\frac{\partial L}{\partial \mu_p} = (N_L + ke + w - 2p) = 0. \tag{A12}$$

$$\frac{\partial L}{\partial \mu_e} = (p - w)(k) - e = 0. \tag{A13}$$

$$\frac{\partial L}{\partial \lambda} = (p - w)(N_L - p) - F - \frac{e^2}{2} = 0. \tag{A14}$$

Solving the above seven equations simultaneously, we obtain the results in Finding 4.