Discriminating Monopoly, Forward Markets and International Trade
Author(s): Rafael Eldor and Itzhak Zilcha
Source: *International Economic Review*, Vol. 28, No. 2 (Jun., 1987), pp. 459-468
Published by: Blackwell Publishing for the Economics Department of the University of Pennsylvania and Institute of Social and Economic Research -- Osaka University
Stable URL: http://www.jstor.org/stable/2526737
Accessed: 17/08/2010 04:11

INTERNATIONAL ECONOMIC REVIEW
Vol. 28, No. 2, June, 1987

# DISCRIMINATING MONOPOLY, FORWARD MARKETS AND INTERNATIONAL TRADE*

BY RAFAEL ELDOR AND ITZHAK ZILCHA[1]

## 1. INTRODUCTION

Recent empirical studies (see e.g. Kravis and Lipsey [1977, 1978], Isard [1977], Aspe and Giavazi [1982]) demonstrate that there are notable divergencies between domestic and export prices. This empirical evidence suggests that the law of one price is systematically violated. Kravis and Lipsey [1977, p. 155] argue that "many firms involved in international trade, particularly manufacturers, are in the position of a discriminating monopolist faced with separate markets, each characterized by a different demand elasticity". A model which explicitly allows for price discrimination has been used by several authors (see for example Aspe and Giavazi [1982], Ethier [1982], Katz, Paroush and Kahana [1982] and Tarr [1979]). Katz, Paroush and Kahana [1982] (hereafter KPK), used a model of a price discriminating firm which operates under price uncertainty, to investigate its optimal level of output and sales in the two markets. The main assumption made in KPK [1982] is that the firm determines its level of output and the allocation of sales between the two markets before the resolution of uncertainty. Furthermore, no forward markets were available to this firm.

In this paper, we analyze a price discriminating firm which sells its produce both in the domestic and on world markets under either exchange rate uncertainty or foreign price uncertainty. This firm is a monopoly in the domestic market but a price-taker on the world market. Our model differs substantially from the KPK model and in some cases conforms better with reality due to the following two assumptions. First, the firm determines its level of output before the resolution of uncertainty but decides about the optimal allocation of sales only after it observes the foreign price denominated in domestic currency. Secondly, forward markets to share the exchange-rate risk or the uncertain foreign commodity price are available and their impact on the firm's policy is analyzed. Hence, this work integrates two strands of literature. It combines studies on price discriminating firms (some were mentioned above) and studies on firm behavior when forward markets are available (Danthine [1978], Holthausen [1979], Katz and Paroush [1979], Feder, Just and Schmitz [1980]). In this paper, we are mainly concerned with a firm which always exports. This includes large

* Manuscript received September, 1985; revised July, 1986.

[1] We are grateful to anonymous referees for their helpful suggestions. We are also grateful to Simon Benninga, Avinash Dixit and Yoram Weiss for their comments. Financial assistance from the Foerder Institute for Economic Research is gratefully acknowledged.

manufacturing firms such as Japanese electronics and car industries or other large firms where the local market is "small".

The paper is organized as follows. In Section 2 the model is presented. The effect of uncertainty on production and export when no forward markets exist is investigated in Section 3. It is shown that, under some conditions, exports increase when uncertainty is introduced. This result seems to contradict the prevalent view that in the firm's microeconomic level, export should decline as a result of introducing uncertain exchange rate (see e.g., Clark [1973] Baron [1976] and Yeager [1976, Ch. 13]). In Section 4, we analyze the impact of introducing forward markets on the firm's output and export. We show that a "separation theorem" holds in this model, i.e., the optimal production level does not depend on the utility function and the probability assessments of the random exchange rate. Moreover, in the presence of forward markets, the total output of the discriminating monopoly increases to that level of the perfectly competitive firm (in both markets) while its export is larger than that of the competitive firm. In Section 5, we discuss the optimal hedging policy of this firm. In Section 6, it is shown that as a result of price discrimination, the domestic price variability is magnified relative to the foreign price variability (denominated in domestic currency), and that this model also gives rise to cyclical dumping (see Tarr [1979]).

## 2. THE MODEL

Consider a firm which produces a homogeneous commodity both for a domestic market where the firm has a monopolistic power and for foreign markets where it faces perfect competition. The assumed separation between domestic and foreign markets which enables this firm to apply price discrimination is due to the existence of artificial and/or natural barriers to trade. The firm faces random exchange rate $\tilde{e}$. Assume that $\tilde{e}$ has a given distribution function on $[e_1, e_2]$, $0 < e_1 < e_2 < \infty$, and that this distribution of $\tilde{e}$ is known to the firm. Denote by $Q^d$ the sales in the domestic market and by $Q^F$ the total sales abroad where the firm is a perfect competitor. Let $P^d(Q^d)$ be the domestic inverse demand function for this commodity, $\eta$ the price elasticity of demand and $P^*$ the foreign price of the commodity.

We assume that the firm is risk-averse with a von Neumann-Morgenstern utility function $U$; $U$ is differentiable, $U' > 0$ and $U'' < 0$. The firm maximizes the expected utility of profits denominated in local currency. The firm's production technology gives rise to a cost function $C(Q)$, where $Q$ is the total output of this commodity (to be allocated for both markets). We assume that $C' > 0$ and $C'' > 0$.

Production usually takes time, hence we assume that the firm chooses its optimal level of output before $\tilde{e}$ is known. Since we are interested in the case where the firm exports, we shall assume that the optimal output of the firm is greater or equal to $Q^d(e_1)$. The timing of output allocation between domestic and foreign markets is a crucial assumption in this model. We believe that the assumption made in Katz-Paroush-Kahana [1982], that the firm allocates its output between the domestic and export before the resolution of uncertainty does not characterize many cases. Shifts of produce from one market to another within a short period of time are usually possible. Therefore, we assume that the allocation of output between the two markets is done after the observation of $\tilde{e}$.

We shall first consider only the cases where the firm exports in all states of the world. This includes large manufacturing firms such as Japanese electronics and car industries or other large firms where the local market is "too small". We frequently witness government intervention to prevent wild fluctuations in the exchange rate which may reduce exports dramatically. Therefore, our assumption that $e_1$ cannot be too small, i.e. a level which eliminates export altogether, seems reasonable. In the last section we shall consider the case where there is no export in some states of the world.

Let us define $B$ as the set of all states of the world where the firm sells in both markets, i.e.

$$B = \{e \mid e \in [e_1, e_2] \text{ and } P^d(0) > eP^*\}.$$

The case where the firm exports all its output in some states of the world is included in our model: thus $B \neq [e_1, e_2]$ is possible. We allow $\sim B$ to be the empty set. Since the exchange rate $\tilde{e}$ is exogenous to the firm there exists some $\hat{e}$ in $[e_1, e_2]$ such that: $B = [e_1, \hat{e}]$. Moreover, $\hat{e}$ does not depend upon the production level of this firm. When $\hat{e} = e_2$, the firm sells in both markets in all states of the world.

In these states of $\tilde{e}$ where the firm sells in the domestic and foreign markets, it equates the marginal revenues, i.e.

$$P^d(Q^d)\left(1 - \frac{1}{\eta}\right) = eP^* \quad \text{for} \quad e_1 \leqq e \leqq \hat{e} \tag{1a}$$

$$P^d(0) \leq eP^* \quad \text{for} \quad e > \hat{e}. \tag{1b}$$

Equations (1a) and (1b) define, implicitly, the amount of commodity $Q^d$ sold domestically as a function of the random variable $\tilde{e}$. For $e > \hat{e}$ $Q^d(e) = 0$. Assuming that the marginal revenue is decreasing it is clear from (1a) that $Q^d(\tilde{e})$ increases as $e$ declines on $[e_1, \hat{e}]$. Define $f(\tilde{e})$ by

$$Q^d(\tilde{e}) = f(\tilde{e}) \quad \text{where} \quad Q^d(\tilde{e}) \quad \text{satisfies (1a)} \quad \text{for} \quad e_1 \leqq \tilde{e} \leqq \hat{e}. \tag{2}$$

$$f(e) = 0 \quad \text{for} \quad e > \hat{e}.$$

The level of output, which is to be determined before the realization of $\tilde{e}$, is attained by maximizing $EU(\tilde{\Pi})$ where $\tilde{\Pi}$ are the (random) profits denominated in domestic currency. In the presence of currency forward market with a forward exchange rate $e_f$, we denote by $X$ the amount of foreign currency that the firm sells forward. $\tilde{\Pi}$ is given by

$$\tilde{\Pi} = \tilde{e}P^*(Q - f(\tilde{e})) + P^d(f(\tilde{e}))f(\tilde{e}) + X(e_f - \tilde{e}) - C(Q). \tag{3}$$

When no forward transaction of foreign exchange is available we take $X\equiv 0$. The firm chooses $Q$ and $X$ (taking into account (1a) and (1b) and the fact that $\hat{e}$ does not depend upon $Q$) to maximize

$$\text{(4)}\quad \max_{Q,X} EU(\Pi(\tilde{e})) = \int_B U[eP^*(Q-f(e))+P^d(f(e))f(e)+(e_f-e)X-C(Q)] + \int_{\sim B} U[eP^*Q+(e_f-e)X-C(Q)].$$

The first-order conditions are:

$$\text{(5)}\qquad E[\tilde{e}P^*-C'(Q)]U'(\tilde{\Pi}) = 0$$

$$\text{(6)}\qquad E(e_f-\tilde{e})U'(\tilde{\Pi}) = 0.$$

By our assumptions about $U(\cdot)$ and $C(\cdot)$, (5) and (6) are necessary and sufficient conditions for optimality. We denote by $\bar{Q}$ the optimal output when $X\equiv 0$ (i.e., the solution to (5) for this case) and by $Q^*$ and $X^*$ the optimal solution when forward market exists. In the next section, we analyze the price discriminating firm's output and sales when $X\equiv 0$.

## 3. THE EFFECT OF UNCERTAINTY ON OUTPUT AND EXPORT

Consider the case where no forward market for foreign exchange is available. It is traditional to compare the firm's optimal output under uncertainty with the certainty equivalent $Q^c$ i.e., with the case where $\tilde{e}$ is replaced by $E\tilde{e}=\bar{e}$ (see for example Sandmo [1971] and Leland [1972]).

PROPOSITION 1. *The optimal output of the price discriminating monopoly under the certain exchange rate $\bar{e}=E\tilde{e}$ is greater than its optimal output under the random exchange rate $\tilde{e}$.*

PROOF. Let us first show that when $X\equiv 0$ the profit $\Pi(\tilde{e})$ is an increasing function in $e$. Let $\theta, \bar{\theta}\in[e_1, e_2]$ and $\theta<\bar{\theta}$. Even if the firm does not reallocate its output when $\tilde{e}=\theta$ between the two markets, in the case where $\tilde{e}=\bar{\theta}$, its profits satisfy:

$$\Pi(\bar{\theta}) \geq \bar{\theta}P^*(\bar{Q}-f(\theta)) + P(f(\theta))f(\theta) - C(\bar{Q}) > \theta P^*(\bar{Q}-f(\theta)) + P(f(\theta))f(\theta) - C(\bar{Q}) = \Pi(\theta).$$

Since a shift in the domestic sale from $f(\theta)$ to $f(\bar{\theta})$ may only increase its profits, then profits are increasing with the exchange rate. Denote by $Q^c$ the output when $\bar{e}=E\tilde{e}$ prevails. Let $A$ be the set of all states of the world where $\tilde{e}\geq(C'(\bar{Q})/P^*)$ then (5) can be rewritten as

$$\text{(7)}\qquad \int_A\left(\tilde{e}-\frac{C'(\bar{Q})}{P^*}\right)U'(\tilde{\Pi}) = \int_{\sim A}\left(\frac{C'(\bar{Q})}{P^*}-\tilde{e}\right)U'(\tilde{\Pi}).$$

Since $U'$ is monotone decreasing and $\Pi(e)$ increases in $e$,

$$\text{(8)} \qquad \sup_{A} U'(\tilde{\Pi}(e)) \leq \inf_{\sim A} U'(\tilde{\Pi}(e)).$$

Combining (7) and (8) yields

$$\int_A \left(\tilde{e} - \frac{C'(\bar{Q})}{P^*}\right) > \int_{\sim A} \left(\frac{C'(\bar{Q})}{P^*} - \tilde{e}\right) \quad \text{or}$$

$$\text{(9)} \qquad E(\tilde{e} - C'(\bar{Q})/P^*) > 0 \quad \text{or} \quad P^*E\tilde{e} > C'(\bar{Q}).$$

But under certainty the firm equates the price and the marginal cost, i.e., $C'(Q^c) = \bar{e}P^*$. Since $C'' > 0$ we proved from (9) that $\bar{Q} < Q^c$. Q. E. D.

Now let us show that under certain assumptions about the demand curve, the impact of uncertainty in $\tilde{e}$ about domestic sales and the exported quantity, in some cases, can be determined.

PROPOSITION 2. *Let the exchange rate be fixed at $\bar{e}$ initially. The effect of a mean-preserving spread in the exchange rate upon the expected domestic and foreign sales will depend upon the shape of the marginal revenue function. Let us introduce a mean preserving spread at $\bar{e}$, then*

(a) *If $MR^d$ is strictly concave*
   (i) *Expected domestic sales decline*
   (ii) *For some risk-averse firms the expected export under the uncertain $\tilde{e}$ is larger than the export under the fixed exchange rate $\bar{e} = E\tilde{e}$.*

(b) *If $MR^d$ is linear the expected domestic sales remain unchanged but export declines.*

(c) *If $MR^d$ is strictly convex expected domestic sales increase while the expected export declines.*

Let us first explain the proposition and its implications. Since the firm is risk averse, making $\tilde{e}$ variable results in lower total production (Proposition 1). However, the impact of introducing uncertain exchange rate on the expected domestic sales depends upon the convexity properties of the marginal revenue function. In the case when $MR^d$ is concave, the expected domestic sales decline. In some cases, these sales may decline more than the reduction in total output, and as a result the expected export may increase. This result seems to contradict the prevalent view that in the firm's microeconomic level export should decline when the exchange rate becomes stochastic (see, for example Clark [1973], Baron [1976] and Yeager [1976]). In practice, many countries have established exchange rate guarantee programs which reduce the variability of the exchange rate (see for example Eldor [1984]) in order to encourage export. Reinterpreting Proposition (2a) implies that in some cases export may decline when the exchange rate is fixed at its expected value $\bar{e}$(even though the exporting firm is risk averse).

PROOF. (a) By definition of $f(e)$ we have $MR^d(f(\tilde{e})) = \tilde{e}P^*$ for all states in $B$. This implies that when $MR^d(\cdot)$ is strictly concave then $f(\tilde{e})$ is strictly concave on $B$. (Since $MR^d$ is a monotone decreasing function it can be verified that sign $MR^{d''} =$

sign $f''$ on $B$). Therefore $Ef(\tilde{e})<f(\bar{e})$ which proves (i). To establish (ii) it is enough to show that for a firm with a low degree of risk aversion we have $Q^c-\bar{Q}<f(\bar{e})-Ef(\tilde{e})$. When $U'$ varies moderately on $[\Pi(e_1), \Pi(e_2)]$ we find from (5) that $E\tilde{e}P^*-C'(\bar{Q})$ is close to 0; therefore, since $C'(Q^c)=\bar{e}P^*$ we obtain that $Q^c-\bar{Q}$ is sufficiently small (assuming that $C''$ is bounded away from 0 on $(Q^C/2, \infty)$). Since the choice of utility function and cost function has no effect upon the difference $f(\bar{e})-Ef(\tilde{e})$ our argument proves (ii).

The proof of (b) follows from the linearity of $f(e)$ (see equations (1a)–(1b)) and Proposition 1. The proof of (c) follows again from the strict convexity of $f(e)$ on $B$. Thus $Ef(\tilde{e})>f(\bar{e})$ and, by Proposition 1, $\bar{Q}<Q^c$ hence $\bar{Q}-Ef(\tilde{e})<Q^c-f(\bar{e})$.

Now let us study the impact of increasing risk aversion upon the level of output and export.

PROPOSITION 3. *As the firm's risk aversion increases its optimal output and export decreases.*

PROOF. Consider two risk averse firms with utility functions $U_A$ and $U_B$. Assume that firm $A$ is more risk averse than $B$, thus $U_A(\cdot)=F(U_B(\cdot))$, where $F'>0$ $F''<0$ (see Pratt [1964]). Denote by $Q_A$ and $Q_B$ the optimal production of these firms. The first order condition for $A$ can be written as

$$(10) \qquad E\{F'[U_B(\tilde{\Pi}_A)]U_B'(\tilde{\Pi}_A)(\tilde{e}-C'(Q_A)/P^*)\} = 0.$$

Using the monotonicity of $\tilde{\Pi}_A$ and $F'$, by a similar argument to the one brought in the proof of Proposition 1, we obtain from (10) that

$$(11) \qquad EU'_B(\tilde{\Pi}_A)(\tilde{e}-C'(Q_A)/P^*) > 0.$$

Since $EU_B(\Pi)$ is concave in $Q$ and its derivative at $Q=Q_B$ is 0 we obtained from (11) that $Q_A<Q_B$. To establish that the export of firm $A$ is smaller than that of firm $B$ (the two firms face the same domestic demand curve), we note that their local sales are the same ($f(e^*)$), and that $Q_B-Q_A>0$. Q. E. D.

## 4. THE IMPACT OF FORWARD MARKETS ON THE FIRM'S OUTPUT AND EXPORT

Now we assume that forward markets for foreign exchange are available. Even though our firm has monopolistic power in the domestic market the next proposition shows that a "separation theorem" holds; i.e., its optimal production level (and hence its exported quantities) does not depend on its utility function or on the particular distribution of $\tilde{e}$. Similar results for competitive firms were obtained by Ethier [1973], Baron [1976], Danthine [1978], Holthausen [1979], Katz and Paroush [1979], Feder Just and Schmitz [1980] and others. From (5) and (6) we can derive the following result:

PROPOSITION 4 (*Separation Theorem*). *When forward markets for foreign exchange are available, the firm's optimal production is given by*

$$C'(Q^*) = e_f P^*. \tag{12}$$

First note that the optimal output $Q^*$ does not depend upon the utility function or on the probability distribution of the random exchange rate. Moreover, the output of this discriminating monopoly is identical to that of a competitive firm (in the presence of forward markets).

For a competitive firm the separation theorem holds, even when the forward market is biased. The reason why this result is valid is that although the firm may not find it optimal to perfectly hedge against total revenue risk, it does find it optimal to perfectly hedge against marginal revenue risk. Since the cost of increasing total revenue risk is the marginal production cost and the cost of increasing the amount the firm hedges through the forward exchange market is given by the forward exchange rate, the firm finds it optimal to equate marginal cost to the forward exchange rate, regardless of risk preference or the distribution over exchange rates. This argument remains true in the price discriminating firm case since it always exports. The reason why one does not anticipate this result is that the firm profit is not linear in the exchange rate for price discriminating firms.

REMARK[2]. This result may be even more robust than indicated by us. The assumption that the firm exports in all exchange rate regimes can be weakened by allowing, for example, the possibility of holding inventory when exchange rates are extremely low. The firm can then be thought of as "exporting into storage" for future disposal rather than necessarily disposing of the product on the domestic market in the current period.

We also observe that since for each realization of $\tilde{e}$ the discriminating monopolist's domestic sales are less than those of a price-taking firm (in the local market), the monopolist firm's export is larger than that of a competitive firm. Thus, abolishing the separation between domestic and foreign markets by reducing tariffs and/or transport costs may increase local sales and decrease firm's export.

COROLLARY. *If the forward price incorporates nonpositive risk premium, i.e.* $e_f \geq E\tilde{e}$, *then the firm's optimal output and expected export are larger in the presence of such forward market.*

The proof of the Corollary is straightforward from Proposition 1 and the equations $C'(\bar{Q}) \leqq \bar{e}P^*$, $C'(Q^*) = e_f P^*$.

## 5. OPTIMAL HEDGING POLICIES: COMPETITION VS. MONOPOLY

The optimal hedge $X^*$ and the optimal production level $Q^*$ of the price discriminating monopoly are determined by equations (5) and (12) and are known to the firm before the resolution of the uncertainty. It is usually difficult to solve

[2] We owe this observation to one of our referees.

explicitly for $X^*$, since the levels of export depend upon the shape of the domestic demand curve. In the case where the currency forward market is unbiased and the firm is a price taker in the domestic market where $P^d = \tilde{e}P^*$, the optimal hedge $X^*$ is equal to $P^*Q^*$, namely, when the forward market is unbiased, the competitive firm fully hedges its foreign currency proceeds and gets rid of uncertainty altogether. Now we show that in our model the optimal hedge of the firm is lower than that of a competitive firm.

PROPOSITION 5. *Assume that the currency forward market is unbiased. The forward hedge of the price discriminating monopoly is lower than that of a competitive firm, i.e.,* $X^* < P^*Q^*$.

Note that even though in both cases the firm produces the same $Q^*$ the hedging policy differs. This occurs since in the "bad" states of nature the price discriminating monopoly shifts produce from the foreign markets to the domestic market which provides the firm with partial natural hedge.

PROOF. When $e_f = E\tilde{e} = \bar{e}$ we derive from the first-order conditions (5) and (6) that the firm chooses $X^*$ such that $\operatorname{Cov}(\tilde{e}, U'(\tilde{\Pi})) = 0$. If $\Pi(e)$ is monotone in $e$ we must have that $\operatorname{Cov}(\tilde{e}, U'(\Pi(\tilde{e})) = 0$. The proof of this fact is similar to that of Proposition 1 using the monotonicity of $U'$. Let $P^* = 1$ then for some constant $k$,

$$\Pi(\tilde{e}) = [Q^* - X^* - f(\tilde{e})]\tilde{e} + P^d(f(\tilde{e}))f(\tilde{e}) + k,$$

but

$$\frac{\partial}{\partial e}[P^d(f(e))f(e)] = \frac{dP^d}{dQ^d} f'(e)f(e) + P^d(Q^d)f'(e)$$

$$= f'(e)P^d(Q^d)[1 - 1/\eta] = f'(e)e.$$

Thus

$$\frac{\partial}{\partial e}[\Pi(\tilde{e})] = Q^* - X^* - f(\tilde{e}) - f'(\tilde{e})\tilde{e} + f'(\tilde{e})\tilde{e} = Q^* - X^* - f(\tilde{e}).$$

Since $\Pi(e)$ cannot be a monotone function of $e$ this implies that $X^* < Q^*$.

Q. E. D.

## 6. PRICE DISCRIMINATING MONOPOLY, DOMESTIC PRICE VARIABILITY AND DUMPING

In this section, we shall consider only cases where the firm sells in the domestic market always (i.e. $\hat{e} = e_2$). In the classic small country models with perfect competition, domestic price variability is precisely the same as the variability of the foreign price denominated in domestic currency. The reason is that in each state of nature $P^d = \tilde{e}P^*$ (*PPP* holds). Thus, we have a perfect correlation. However, in our price discriminating monopoly case, we equate marginal revenues in each state of nature, thus

$$P^d(Q^p)\left(1-\frac{1}{\eta}\right)=\tilde{e}P^*.$$

Where the monopoly always sells in that portion of the domestic demand curve where the price elasticity of demand $\eta > 1$. Since in each state of nature $(1-1/\eta) < 1$, $P^d$ will be more variable than $\tilde{e}P^*$, namely we observe here a magnification effect. This conclusion holds also in the case of an importing firm with a monopoly power in the domestic market (due to some licensing regulations for imporg for example).

Let us define $r(\tilde{e}) = \frac{\tilde{e}P^*}{P^d}$, i.e. the relative price of export which is closely related to dumping (see Tarr [1979]). Rewriting the above equation we obtain,

$$r(\tilde{e}) = 1 - \frac{1}{\eta}. \tag{13}$$

It is reasonable to assume that the (local) price elasticity of demand is higher whenever $P^d$ is higher. In this case we obtain from (13) that when the exchange rate $e$ is lower, $r(e)$ is lower in accordance with the cyclical dumping hypothesis (see Tarr [1979, p. 59]).

## 7. CONCLUSIONS

In this model we considered a price discriminating firm that has a monopoly power in the domestic market and it is a perfect competitor in the foreign market. In our view, this model of price discrimination approximates reality in many cases and can be extended to the case where the firm obtains some monopolistic power in the foreign market as well. Clearly, in such a case, some of the results may fail to hold, for example, the separation theorem.

Consider now the case where the firm does not export in all states of nature. One can easily see that equation (5) *does not* hold in this case. Therefore, Propositions 1 and 4 are not valid.

To see why Proposition 1 may not hold, consider the case where $\tilde{e}$ assumes only two values $\{e_1, e_2\}$ with equal probabilities where $e_1 < e_2$. The firm sells in both markets when $\tilde{e} = e_2$ and it sells only in the domestic market when $\tilde{e} = e_1$. Consider a case where $MR^d(Q^d)$ decreases very slowly (as $Q^d$ increases), the marginal cost $C'(Q)$ increases moderately and the export at fixed exchange rate $\bar{e}$, $Q^c - Q^d(\bar{e})$, is small. By increasing the variance of $\tilde{e}$, i.e. increasing $e_2 - e_1$ while $E\tilde{e} = \bar{e}$, the firm may benefit (in the expected utility sense) by increasing its output beyond $Q^c$ (note that $\bar{e}P^* = C'(Q^c)$). In the "bad" state, $e_1$, its losses are moderate (it sells all the output in the domestic market, resulting in a moderate drop in the total revenues), while in the case $\tilde{e} = e_2$ the firm enjoys big profits. For some fixed $Q > Q^c$ the firm bears no extra losses as we increase $e_2 - e_1$ (where $E\tilde{e} = \bar{e}$) while it gains larger profits in the state $\tilde{e} = e_2$.

Although we have considered uncertain exchange rate, we could have considered, alternatively, uncertainty about the foreign price while the exchange rate is fixed, without any significant differences in our results. Also, one can consider this model where the firm faces both foreign price and exchange rate uncertainty (see e.g. Benninga, Eldor and Zilcha [1985] in the perfect competition case). If forward markets for the exchange rate and the commodity are available, the separation theorem will still hold. However, this model is beyond the scope of this paper.

*Tel-Aviv University, Israel*

REFERENCES

ASPE, P. AND F. GIAVAZZI, "The Short Run Behavior of Prices and Output in the Exportables Sector," *Journal of International Economics*, 12 (1982), 83–93.

BARON, D. P., "Fluctuating Exchange Rates and the Pricing of Exports," *Economic Enquiry* (1976), 425–438.

BENNINGA, S., R. ELDOR AND I. ZILCHA, "Optimal International Hedging and Output Policies in Commodity and Currency Forward Markets," *Journal of International Money and Finance*, 4 (1985), 537–552.

CLARK, P. B., "Uncertainty, Exchange Risk, and the Level of International Trade," *Western Economic Journal* (September, 1973), 302–313.

DANTHINE, J. P., "Information, Futures Prices, and Stabilizing Speculation," *Journal of Economic Theory*, 17 (1978), 79–98.

ELDOR, R., "On the Valuation of Currency Options and Exchange Rate Insurance Programs," *Economics Letters*, 16 (1984), 129–136.

ETHIER, W. J., "Dumping," *Journal of Political Economy*, 90 (1982), 487–506.

———, "International Trade and, Forward Exchange Market," *American Economic Review*, 63 (1973), 494–503.

FEDER, G., R. E. JUST AND A. SCHMITZ, "Futures Markets and the Theory of the Firm under Price Uncertainty," *Quarterly Journal of Economics*, 94 (1980), 317–328.

HOLTHAUSEN, D. M., "Hedging and the Competitive Firm under Price Uncertainty," *American Economic Review*, 69 (1979), 989–995.

ISARD, P., "How Far can we Push the Law of One Price," *American Economic Review*, 67 (1977), 942–948.

KATZ, E. AND J. PAROUSH, "The Effect of Forward Markets on Exporting Firms," *Economic Letters* (1979), 271–274.

———, ——— AND N. KAHANA, "Price Uncertainty and the Price Discriminating Firm in International Trade," *International Economic Review*, 23 (1982), 389–400.

KRAVIS, I. B. AND R. E. LIPSEY, "Export Prices and the Transmission of Inflation," *American Economic Review*, 67 (1977), 155–163.

——— AND ———, "Price Behavior in the Light of Balance of Payments Theories," *Journal of International Economics*, 8 (1978), 193–246.

LELAND, H. E., "Theory of the Firm Facing Uncertain Demand", *American Economic Review*, 62 (1972), 278–291.

PRATT, J. W., "Risk Aversion in the Small and in the Large," *Econometrica*, 32 (1964), 122–136.

SANDMO, A., "On the Theory of the Competitive Firm under Price Uncertainty," *American Economic Review*, 61 (1971), 65–73.

TARR, D. G., "Cyclical Dumping: The Case of Steel Products," *Journal of International Economics*, 9 (1979), 57–63.

YEAGER, L., "Exchange Risk as an Obstacle to International Trade and Investment," *International Monetary Relations: Theory, History, and Policy* (New York: Harper and Row, 1976), Chapter 13.