EXCHANGE RISK IN INTERNATIONAL TRADE UNDER ALTERNATIVE EXCHANGE SYSTEMS: THE DEVELOPING COUNTRIES' EXPERIENCE

by

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ABSTRACT

EXCHANGE RISK IN INTERNATIONAL TRADE UNDER ALTERNATIVE EXCHANGE SYSTEMS: THE DEVELOPING COUNTRIES' EXPERIENCE

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The question of exchange risk under different international monetary systems has been the subject of considerable debate over the last few decades. It is a central issue in the evaluation of alternative exchange systems. Till recently, however, the debate was confined to a theoretical level, because little opportunity existed for empirical investigation. With the breakdown of the IMF system of pegged exchange rates in 1973, an empirical investigation of this issue becomes possible. The question whether exchange risk is higher under floating rates or not is examined in this study in the context of the developing countries' claim that

(1) The increased exchange risk present under floating rates has hampered their export drive, and

(2) Their exports are becoming increasingly concentrated as a result of the asymmetry of exchange risk under the present international monetary system.

There are theoretical and empirical dimensions to these two issues. Theoretically, it needs to be determined whether an increase in exchange risk would affect export levels. If so, under what conditions? Then, two empirical questions arise. Whether exchange risk increased with the introduction of floating rates. And if it did, whether the exports of the developing countries were adversely affected by it.

Examining the theoretical issue in the framework of the theory of the firm, it was found that when exchange markets were imperfect, exports could be expected to decline in the face of higher levels of exchange risk.

Exchange risk was defined as a function of past forecasting experience. It was posited that the more inaccurate the forecasts, the higher the exchange risk was perceived to be. The Box-Jenkins method of time series analysis was used to develop a model of exchange rate forecasting in the five developing countries in the sample--India, Israel, Mexico, Korea and Taiwan. It was found that exchange risk had indeed increased since the inception of floating rates in 1973, for each of the five countries.

The effect of this increase in exchange risk on the exports of the five countries was examined econometrically. The result of this examination did not reveal any statistically significant relationship between exchange risk and exports.

Therefore, the conclusions of this research are:

(a) On a theoretical level, exporting firms in developing countries can be expected to curtail their exports when faced with increased exchange risk.

(b) Exchange risk, measured as a function of past forecasting errors, did increase with the introduction of floating rates in 1973.

(c) In spite of these two findings, there was no statistically significant empirical support for the proposition that the exports of developing countries have been adversely affected by the higher level of exchange risk under the present international monetary system. Neither the volume nor the geographical diversification of exports were reduced because of increased exchange risk.

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CHAPTER 1

INTRODUCTION AND OBJECTIVES OF STUDY

The issue of exchange risk under alternative international monetary systems has been the subject of considerable debate in the last few decades. It is a central issue in the evaluation of various exchange mechanisms. Till recently, however, the debate has been largely confined to a theoretical level, because little opportunity existed for empirical investigation, except in an historical context, or for Canada which floated its currency during the 1950's. Since the inception of the IMF system following the meetings at Bretton Woods, pegged rates have been the norm. In addition, the interwar period and the Canadian experience with floating rates are both charaterized by unusual circumstances, severely limiting the extent to which findings in these contexts can be generalized. The emergence of a system predominated by floating rates in 1973, following the breakdown of the IMF Bretton Woods system, provides an opportunity to examine this issue empirically.

The Bretton Woods system functioned relatively smoothly till the 1960's when it began experiencing considerable strain as confidence in the U.S. dollar eroded. The U.S. dollar was the center currency under the system which, for this reason, was often referred to as the dollar-exchange standard. The continuing pressure on the U.S. dollar culminated in the closing of the 'gold window' and then the devaluation of the dollar under the terms of the Smithsonian Agreement in 1971. These actions represented deviations from the central precepts of the IMF system. Consequently, as could have been expected, they provided only temporary respite. The dollar came under renewed attack in early 1973. A second devaluation resulted, but this did not stem the run on the dollar. As a result, the foreign exchange markets were closed for three weeks in March 1973, to allow the central bankers to work out a solution.[1]

The international monetary system that emerged once the markets were re-opened was really a hybrid of pegged and floating rates. Specifically, four subsystems could be delineated:

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[1]For a lucid account of the circumstances leading to and surrounding the eventual breakdown of the IMF Bretton Woods system, see Kreinin, M.E., International Economics: A Policy Approach, 3rd ed., pp. 180-187 (New York, NY; Harcourt, Brace & Jovanovich, 1979).

1) Floating rates adopted by most industrial nations. These included the United Kingdom, Canada, Japan and Switzerland, among others. These countries floated their currencies independently against the U.S. dollar, thus effectively making the U.S. dollar a floating currency as well.

2) The joint float adopted by the six original members of the EEC plus Norway and Sweden. These countries pegged their exchange rates to one another and floated jointly against the dollar. On March 13, 1979, the 'snake' was replaced by the European Monetary System (EMS) in which all nine members of the European Community except the United Kingdom participate. Under the EMS, a European Currency Unit (ECU) was created as a basket of fixed amounts of the nine currencies of the EC members. Central rates for participating currencies were established, and fluctuations were to be kept within a 2.5 percent band around these central rates.[2] An interesting feature of the new system is the use of a 'divergence indicator' which is triggered when a currency moves outside a very tight band around the central rate. When this happens, the country in question is expected to initiate corrective measures.

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[2] Countries not members of the 'snake' could set a 6 percent band temporarily. Italy took advantage of this provision.

Thus, from our present perspective, the main feature of the EMS is that the joint float is made 'tighter.'[3]

Both the independent floats and the joint float were of the managed ('dirty float') type, with governments intervening aggressively in the foreign exchange markets to support their currencies.

3) The pegged rates retained by most of the developing countries. The U.S. dollar, the UK pound and the French franc were the most common pegs. Pegging their exchange rates to a currency that was itself floating meant that the currencies of the developing countries were also floating against all other currencies, jointly with the currency they were pegged to.

4) The exchange rates pegged to a basket of currencies which was adopted by some of the developing countries. The SDR was the choice of most of the oil exporting nations, whereas other countries pegged their currencies to baskets of their own composition. Presumably, the baskets were selected so that they most closely reflected the country's trade structure.

Economists who accepted the superiority of floating rates saw the new system as a step in the right

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[3] For details regarding the EMS, the method of determining the divergence limits, etc., see, "EMS Comes Into Force After Summit Agreement: New Currency Rates Set", IMF Survey, March 19, 1979, p. 81, and "The European Monetary System", IMF Survey Supplement, March 19, 1979, pp. 97-100.

direction. Others were not so sure. Many of the developing countries argued for a return to a system of pegged rates. Their argument essentially rests on the claim that exchange risk had increased under the new system, and that as a direct consequence, their export drive is being hampered. All this has brought the old question of exchange risk under alternate exchange regimes to the forefront once again.

As the developing countries see it, the higher level of exchange risk under the floating rate system translates into lower exports.[4] In addition, they claim that the considerable progress developing countries have made in diversifying their exports geographically in the last two decades is being reversed, if not negated. The geographical concentration would be a direct consequence of the hybrid nature of the new monetary system. Clearly, any increase in exchange risk can be expected

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[4] Although exchange risk will presumably affect imports also, only the export side is examined in this study. Developing countries understandably perceive a reduction in exports with more alarm than a reduction in imports. In addition, quotas and exchange restrictions affect various imported commodities asymmetrically. Because it is rather difficult to isolate such differential influences when aggregates are considered, imports are more difficult to examine than exports. On the export side, exchange restrictions and other interventions generally tend to be invariant with commodity classification.

to be asymmetrical, being lower for the currency to which the developing country is pegged and higher for all other currencies. Thus, exports will tend to be biased towards the former and away from the latter group of countries.

Hitherto, such claims would have had to be analyzed in a theoretical framework. But now, with the change from pegged to floating rates in 1973,[5] they can be analyzed both theoretically and empirically. The objective of this study is to conduct such an investigation for five developing countries, India, Israel, Korea, Mexico and Taiwan. Initially, a broad cross-section of countries in terms of geographic location and income level was contemplated for this study. Because of a severe lack of data, however, only the above five countries were left from the original sample.

In order to examine the developing countries' claim, this study seeks to answer the following questions:

1. Whether the claims have theoretical validity, i.e., from a strictly theoretical perspective, is there reason to believe that exchange risk

[5]The exact date of transition from one system to the other is difficult to determine because there has been considerable turbulence in the international monetary arena since 1971. This issue is dealt with in detail in Chapter 4.

could affect export levels? This question is addressed in Chapter 2.

2. Did exchange risk increase with the introduction of floating rates? The specification and measurement of exchange risk under the two systems (pegged vs. floating rates) is undertaken in Chapter 4.

3. Even if the conclusions pertaining to these two questions is in the affirmative, does the empirical evidence indicate that developing countries' exports have

    a) undergone a significant structural shift as a result of the higher level of exchange risk under the floating rate system, and

    b) become biased towards the center country (the country to which their currency is pegged) due to the asymmetry in any increase in exchange risk?

The theoretical specification of the models needed to examine these two issues is developed in Chapter 3. The empirical testing procedure and results are presented in Chapter 5.

A précis of the study and the main conclusions resulting from it can be found in Chapter 6.

CHAPTER 2

EXCHANGE RATE UNCERTAINTY AND THE LEVEL OF INTERNATIONAL TRADE

The purpose of this chapter is to examine the manner in which the decisions of an exporting firm in a developing country are influenced by exchange rate uncertainty. This problem is analogous to that of a domestic firm facing price uncertainty (domestic in the sense that its output is sold on domestic markets). The exporting firm usually has the option of hedging against exchange risk through operations in the forward exchange market. Accordingly, investigations of the exporting firm have explicitly incorporated a forward market for foreign exchange in their models. Domestic firms, too, have facilities for reducing their exposure to price uncertainty. In some instances, a futures market exists for the output of the firm. In addition to or in lieu of futures markets, domestic firms can and generally do enter into long-term contracts with buyers of their products. This serves the purpose of reducing exposure to price risk much like futures ma

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markets do. Clearly, then, exchange risk for a trading firm can be analyzed in the same manner as price uncertainty for a domestic firm.

So far, investigations of the domestic firm facing price uncertainty have abstracted from the futures market or other means that a domestic firm has of hedging against price risk.[6] Since the two problems are analogous, the results of the present investigation fill this void and this is an important extension of the theory of the firm--both of the domestic and of the trading types.

The problem of the trading firm has been analyzed in the literature but the results are, by and large, contradictory and inconclusive. Some authors conclude that exchange rate uncertainty does not affect the output decisions of a trading firm, so long as a forward exchange market exists.[7] Others have contended that forward markets do not fully eliminate the effects of exchange rate uncertainty, and therefore, output decisions will

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[6] Sandmo, Agnar, "On the Theory of the Competitive Firm Facing Price Uncertainty", AER, March 1971, pp. 65-73, and Coes, Donald V., "Firm Output and Changes in Uncertainty", AER, March 1977, pp. 249-251.

[7] Ethier, Wilfred, "International Trade and the Forward Exchange Market", AER, June 1973, pp. 494-503. McKinnon also examines the question of optimal hedging in McKinnon, Ronald I., Money in International Exchange, pp. 89-93 (New York, NY; Oxford University Press, 1979). His examination is even more constrained than usual. First, he separates the production from the hedging decision. Second, he assumes that the forward rate is equal to both the present spot rate and the future spot rate. Third, perfect forward markets are assumed. His model bears a striking resemblance to Ethier's model and the results are also similar.

be influenced by changes in uncertainty.[8,9] The reasons for the contradictory findings can be traced to some particularly artificial assumptions adopted in these investigations, making their results special cases incapable of being applied generally. All three studies mentioned above assume, for instance, that the utility of profits is a quadratic function. Arrow[10] has shown that quadratic utility functions violate the intuitive and widely accepted concept of decreasing absolute risk aversion. In addition, it is commonly assumed that forward exchange markets are perfect in the sense that costs are insignificant and that cover can be obtained for all currencies and for any maturity without affecting the forward rate. Such an assumption is questionable even for developed countries. For developing countries, it amounts to a distortion of reality. Consequently, results founded on such premises are questionable, and do not lend themselves to generalization.

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[8] Clark, Peter B., "Uncertainty, Exchange Risk and the Level of International Trade, Western Economic Journal, September 1973, pp. 302-313.

[9] Hooper, Peter and Kohlhagen, Steven W., "The Effect of Exchange Rate Uncertainty on the Prices and Volume of International Trade", unpublished manuscript, Federal Reserve Board, 1978.

[10] Arrow, Kenneth J., Essays in the Theory of Risk-Bearing, pp. 90-120 (Chicago, Ill.; Markham Publishing Company, 1971).

They are certainly not applicable to developing countries.[11]

Several imperfections in the financial markets of developing countries have been identified which have the combined effect of imposing substantial costs on transactions in the forward exchange market.[12] Among these, the following are especially pertinent to the present investigation:

1) In developing countries, the forward exchange markets are not sufficiently wide or deep to ensure that forward transactions in all currencies and for all maturities will be 'perfect.' For instance, the market for irregular maturities (as opposed to multiples of 30 days) are either non-existent or notoriously thin. Thus, the forward rates obtained by a firm for such irregular maturities is bound to be sensitive to the volume of transactions by the firm. The rates would incorporate additional premiums, which can be interpreted as costs resulting from the nature of the forward

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[11] It should be acknowledged that the studies referred to above did not intend to explain the behavior of exporting firms in developing countries specifically. Thus, they are not subject to criticism in the treatment of the problem. The point being made is that the results cannot be applied to developing countries.

[12] Black, Stanley W., "Exchange Policies for Less Developed Countries in a World of Floating Rates", Essays in International Finance (#119), (Princeton, NJ: International Finance Section, Princeton U, December 1976).

market. The lack of breadth implies, similarly, that it would be costly or impossible for a firm to obtain cover in certain currencies.

2) Exchange control, which is in force in most developing countries, also imposes certain costs on the trader. In most countries, forward cover is provided exclusively by the government. For this reason alone, there is apriori reason to believe that the costs of forward transactions can be substantial. The government, unhindered by competitive pressure, has little incentive to minimize the difference between its buying and selling rates.

3) Geographically, too, the forward market is rather stratified, being concentrated in a few selected urban centers. Exporters in surrounding areas typically have to incur considerable costs in finding a market. In addition, information costs even between two metropolitan areas can be substantial due to inefficient communications links.

4) As Black points out, the size of even European markets is small compared to the market in New York.[13] The size consideration is even more important in the case of developing countries. When the size of the market is small, it is not economic to develop a wide

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[13]*Ibid.*, p. 20.

network of dealers, brokers, interbank arrangements etc., that are essential for the smooth operation of the market. Most versions of exchange control restrict or prohibit citizens from holding and trading in foreign exchange. Therefore, exporters in these countries cannot avoid the high costs of the domestic market by shifting their dealings to the New York or some other well-developed market.

In order to keep the present investigation general, a Von Neumann-Morgernstern type utility function is employed, with only one restriction imposed on it--that of decreasing absolute risk aversion in the Arrow-Pratt sense.[14] And to incorporate the imperfections commonly found in the financial markets of the developing countries, it is assumed that there is a non-trivial cost associated with forward exchange transactions. This cost is a function of the volume of transactions undertaken.

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[14]Arrow, op.cit., p. 96.

THE MODEL

Consider, then, the case of an exporting firm operating under the following conditions:

1) The firm produces one homogeneous good, q, exclusively for export. The export market is assumed to be perfectly competitive. Thus, the price in foreign currency, p, is determined exogenously.

2) The firm commits resources to production only after export orders are secured, so that the foreign price is known with certainty at the time the production decision is made.

3) The firm is paid in foreign exchange. It can convert this to domestic currency through the forward market today (at the known forward rate, f) or through the spot market when payment is received.

4) The future spot rate at which uncovered exchange receipts are converted is a random variable, r, with a known expected value, $\bar{r}$, based on the firm's subjective probability distribution for r. This is the source of all uncertainty in the model.

5) The cost functions for production and for operations in the forward market are assumed to be known with certainty, i.e., they are non-stochastic. The usual assumptions about positive and increasing

marginal costs apply, to ensure stability in these activities. Also, marginal cost is assumed to be zero at the origin.

We can then write the firm's profit function in terms of domestic currency, as follows:

PROFITS: $\pi \equiv \alpha pfq + (1-\alpha)prq - C_1(q) - C_2(\alpha pfq)$

Where:

α = proportion of foreign exchange sold through the forward market.

p = price in terms of foreign currency

q = quantity of output

f = the forward exchange rate: $\left[\frac{\text{domestic currency}}{\text{foreign currency}}\right]$

r = the future spot exchange rate, a r.v. with an expected value of $\bar{r}$ based on a subjective probability distribution: $\left[\frac{\text{domestic currency}}{\text{foreign currency}}\right]$

$c_1(q)$ = the known (non-stochastic) cost function for production, with $C_1'>0$.

$c_2(\alpha pfq)$ = the known (non-stochastic) cost function for operating in the forward market with $C_2' \gtreqless 0$ as $\alpha pfq \gtreqless 0$, and $C_2''>0$.

The exporter seeks to maximize the expected utility of profits, where the utility function is of the Von Neumann-Morgernstern type, so that $U'>0$ and $U''<0$, i.e., the firm is risk-averse.

Therefore, the objective function is:

$$\underset{q,\alpha}{\text{Max.}}: E[U(\pi)] \equiv E\{U[\alpha pfq + (1-\alpha)prq - C_1(q) - C_2(\alpha pfq)]\}$$

Necessary and sufficient conditions for a maximum are

$$\frac{\partial E[U(\pi)]}{\partial q} \equiv U_q = E\{U'[\alpha pf + (1-\alpha)pr - C_1' - C_2'\alpha pf]\} = 0 \tag{2.1}$$

$$\frac{\partial E[U(\pi)]}{\partial \alpha} \equiv U_\alpha = E\{U'[pfq - prq - C_2'pfq]\} = 0 \tag{2.2}$$

and the second-order conditions

$$U_{qq},\ U_{\alpha\alpha} < 0, \quad \text{and} \quad D \equiv U_{qq}\, U_{\alpha\alpha} - (U_{q\alpha})^2 > 0$$

are satisfied.

U_{ij} is defined as $\frac{\partial^2 E[U(\pi)]}{\partial i\ \partial j}$

Since $U'>0$, 2.2 can be written as:

$$E[U'pr] = E[U']pf(1-C_2') \tag{2.2'}$$

Similarly, 2.1 can be written as:

$$E\{U'[1-\alpha)pr - C_1"]\} = -E[U'][\alpha pf(1-C_2')]$$

and, substituting for $E(U')pf(1-C_2')$ from 2.2', we have the result,

$$E\{U'pr\} = E[U']C_1' \qquad (2.1')$$

Combining 2.1' and 2.2', we can write the first order condition for a maximum as:

$$E[U']pf(1-C_2') = E[U']C_1'$$

Eliminating E(U') this becomes:

$$pf(1-C_2') = C_1' \qquad (2.3)$$

In order to establish the relationship between the output and the exchange operations through the forward market, 2.3 can be graphed by noting that:

$$\frac{\partial}{\partial\alpha}[pf(1-C_2')] = -p^2f^2q\ C_2" < 0$$

$$\frac{\partial}{\partial q}[pf(1-C_2')] = -\alpha p^2f^2C_2" \begin{cases} > 0 \text{ when } \alpha < 0 \\ < 0 \text{ when } \alpha > 0 \\ = 0 \text{ when } \alpha = 0 \end{cases}$$

This is done in Figure 2.1.

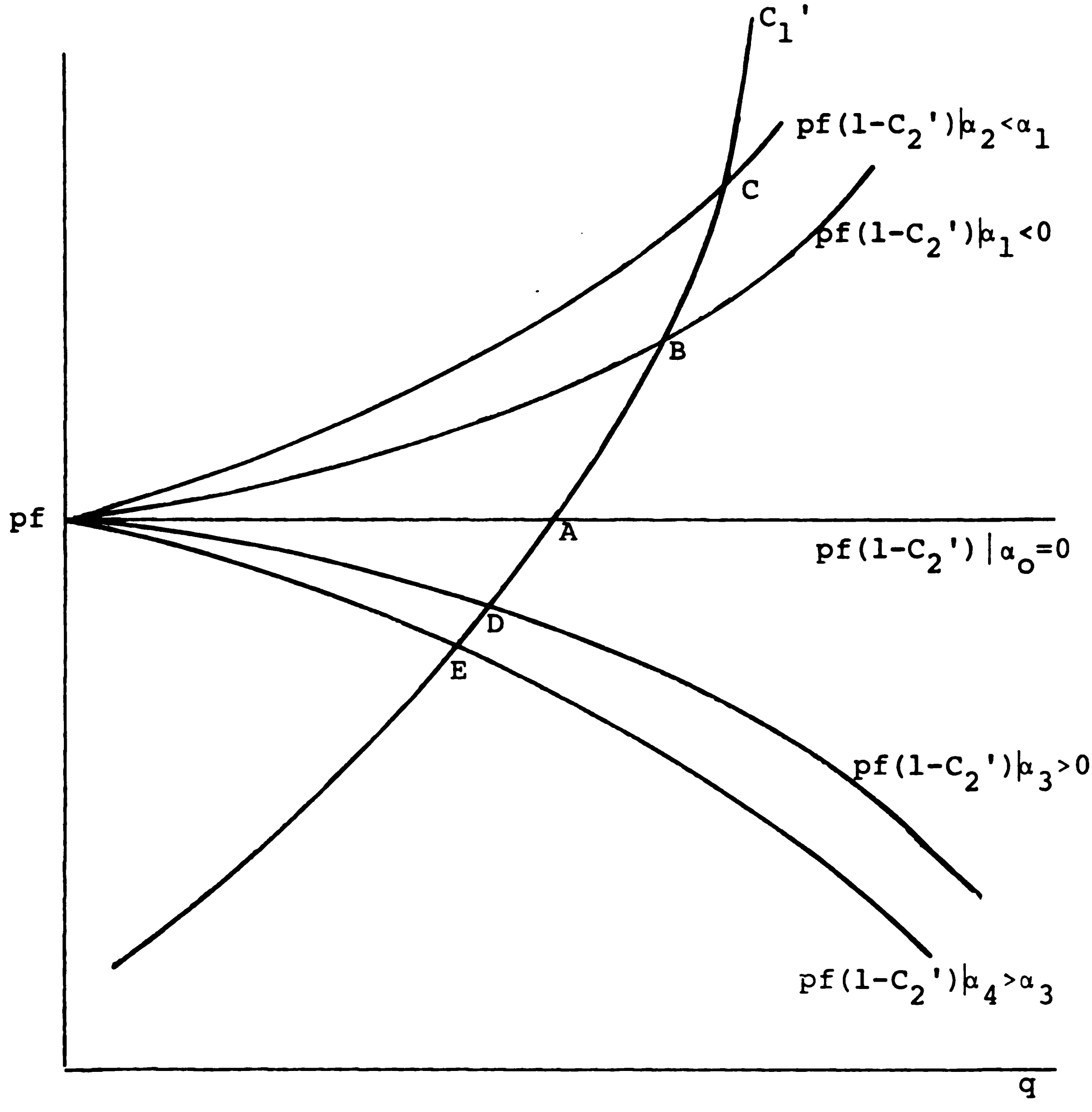

Figure 2.1

Optimal Production and Hedging

It is clear that α and q change inversely. As α declines from α_4 to α_3, the optimal output which satisfies 2.3 increases from E to D.

As α declines further, say to α_o, the output increases to A. And, in fact, output increases each time α declines (to B at $\alpha_1<0$ and to C at $\alpha_2<\alpha_1$).

We have said nothing, so far, about the firm's expectations of the future spot rate ($\bar{r}$) which is necessarily an important variable in the decision process. In order to see how the firm's expectations come into play, we first note that from the profit function,[15]

$$\pi = E(\pi) + (1-\alpha)pq(r-\bar{r})$$

From which it follows that

$$U'(\pi) \leq U'(E\pi) \quad \text{for} \quad (1-\alpha)(r-\bar{r}) \geq 0 \qquad (2.4)$$

or, multiplying both sides by $(1-\alpha)(r-\bar{r})$,

$$U'(1-\alpha)(r-\bar{r}) \leq U'(E\pi)(1-\alpha)(r-\bar{r}) \quad \text{for all } \alpha \text{ and } r. \qquad (2.5)$$

If $(1-\alpha)(r-\bar{r})$ were negative, the inequality in 2.4 would be reversed, but upon multiplication by $(1-\alpha)(r-\bar{r}) < 0$, the inequality in 2.5 is preserved.

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[15] The procedure adopted is similar to Sandmo, op.cit., p. 67.

Taking expectations of both sides and noting that $E\pi$ is a given number,

$$E\{U'(1-\alpha)(r-\bar{r})\} \leq U'[E\pi](1-\alpha)E(r-\bar{r})$$

The right side goes to zero and thus,

$$E\{U'(1-\alpha)(r-\bar{r})\} \leq 0 \qquad (2.6)$$

Substitution into the first order condition 2.2' yields:

$$E[U'](1-\alpha)\bar{r} \geq E[U']f(1-C_2')(1-\alpha)$$

or $$E(1-\alpha)[\bar{r} - f(1-C_2')] \geq 0 \qquad (2.7)$$

It can be shown that the equality will hold if and only if $\alpha = 1$ (see Appendix 1 for a proof). Hence, we can say that

$$\bar{r} = f(1-C_2') \iff \alpha = 1 \qquad (2.8)$$

$$\bar{r} > f(1-C_2') \iff \alpha < 1 \qquad (2.9)$$

$$\bar{r} < f(1-C_2') \iff \alpha > 1 \qquad (2.10)$$

Furthermore, it is clear from equations 2.8 through 2.10 that

$$\alpha \leq 0 \quad \Rightarrow \quad \bar{r} > f \tag{2.11}$$

$$0 < \alpha < 1 \quad \Rightarrow \quad \bar{r} \gtreqless f \tag{2.12}$$

$$\alpha \geq 1 \quad \Rightarrow \quad \bar{r} < f \tag{2.13}$$

since C_2' is negative only when $\alpha < 0$,
which imply that

$$\alpha < 1 \quad \Leftrightarrow \quad \bar{r} \geq f \tag{2.14}$$

$$\alpha > 0 \quad \Leftrightarrow \quad \bar{r} \leq f \tag{2.15}$$

Similarly, substitution of 2.6 into 2.1' yields:

$$E[U']p\bar{r}(1-\alpha) \geq E[U']C_1'(1-\alpha)$$

or, $(1-\alpha)(p\bar{r} - C_1') \geq 0$, with equality holding if and only if $\alpha = 1$ (see Appendix 1 for a proof). Thus, it is clear that,

$$\alpha = 1 \quad \Leftrightarrow \quad p\bar{r} = C_1' \tag{2.16}$$

$$\alpha < 1 \quad \Leftrightarrow \quad p\bar{r} > C_1' \tag{2.17}$$

$$\alpha > 1 \quad \Leftrightarrow \quad p\bar{r} < C_1' \tag{2.18}$$

We can now incorporate equations 2.7 to 2.18 into our graphical representation of the first order condition 2.3, as shown in Figure 2.2.

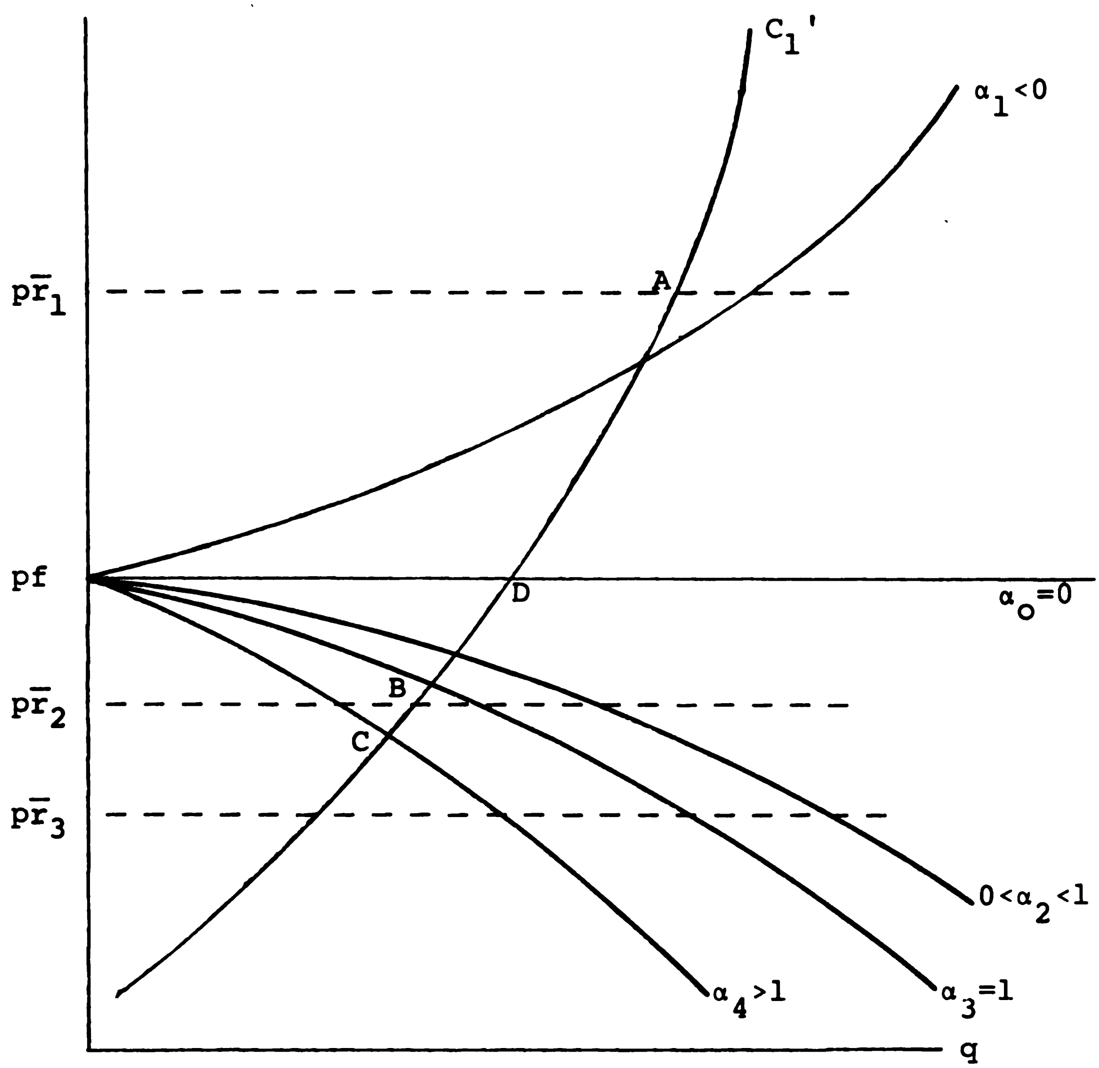

Figure 2.2

Expected Future Spot Rates and Optimal Production and Hedging

If the expectation of the future spot rate is higher than the forward rate, then from equation 2.14, it is clear that α will be set at less than one. Exactly where the firm's optimum will be will depend on the firm's attitude towards risk, the spread between the two rates, and the confidence it attaches to $\bar{r}$ (we shall return to this point later). In view of the first order condition, all we can say is that the equilibrium point will lie on the marginal cost curve, C_1'. Suppose $\bar{r} = \bar{r}_1$ as shown in the figure. Then AB is the range within which the firm will operate.

It can choose a quantity of output between A and B, and can choose an appropriate α (less than unity) such that the firm is at a point on C_1' between AB. Clearly, several combinations of α and q can be chosen to reach this optimum. In any event, A represents a ceiling on the quantity of output, and on the extent of overt speculation that will be undertaken by the firm against the domestic currency. Point B on the other hand represents the minimum output and the maximum amount of cover that will be sought. Presumably, the less risk-averse a firm is, the closer it will choose to be to point A and vice versa.

Now suppose that the expected future rate is below the forward rate, say $\bar{r}_3$. In this situation, a negative α will not be selected (see equation 2.15). Point C represents the lower limit on output and the ceiling on overt speculation against the foreign currency. Correspondingly, point D is now the ceiling on output and the lower limit for the extent to which the exporting firm maintains a long position in the foreign currency.

One interesting implication of these results is that it provides a clear set of criteria for distinguishing between overtly speculative behavior (against the domestic or foreign currency) and hedging activities--a distinction that has not been made too clearly in existing literature.

There is a consensus in the literature that a choice of α outside the range of zero and one represents overtly speculative behavior either against the domestic currency ($\alpha<0$) or against the foreign currency ($\alpha>1$). It is within the range $0<\alpha<1$ that there is confusion, and which the present analysis clarifies. Some authors suggest a value of $\alpha=1$ as the criteria to distinguish pure traders from speculators. Any value of α different from one is seen as speculative behavior, either against the domestic currency ($\alpha<1$) or against the foreign currency ($\alpha>1$). A pure trader would always set $\alpha=1$. In this view, so long as α is less than one, a speculative motive is implied regardless of whether the value of α is negative or not. But, as Einzig points out, banks consider transactions to be speculative only when α is negative (or greater than one) and are reluctant to provide forward cover in these cases.[16] For example, New York banks have been found to charge a ten percent margin deposit for such transactions.[17] Such a distinction between transactions where $\alpha<0$ or $\alpha>1$ and where $0<\alpha<1$ is also more intuitive.

Ethier presents another method for distinguishing between trading and speculative transactions. In his view, a choice of α different from $1-\gamma$ (where γ is a measure of the sensitivity of domestic prices to changes in the exchange rate) immediately implies that pure speculation is being undertaken.[18]

Both these approaches assume that firm behavior can realistically be portrayed by 'razor-edge' criteria. If a firm sets α equal to some critical value (either 1 or, in Ethier's framework, $1-\gamma$) it is merely hedging, whereas if it sets α equal to any other value it automatically becomes a speculator. It is doubtful if

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[16] Einzig, P., A Dynamic Theory of Forward Exchange, pp. 104-106 (London, Macmillan & Co., 1967).

[17] Grubel, H.G., Forward Exchange, Speculation and the International Flow of Capital, p. 102 (Stanford, CA; Stanford University Press, 1966).

[18] Ethier, op.cit., p. 497.

firm behavior can be represented in such an inflexible manner. More intuitive and reasonable is the result of the present study. A firm would not set α less than zero or higher than one except for purely speculative reasons. There is consensus in the literature too regarding this, and it warrants no elaboration. On the other hand, this study concludes that a firm may set α between zero and one for *either* hedging purposes *or* for pure speculation. An unambiguous answer to whether a firm is speculating or hedging when it sets α between zero and one can only be obtained by examining the circumstances underlying the transaction. This statement is clarified below.

According to equations 2.14 and 2.15, a firm may set α in this range ($0<\alpha<1$) when $\bar{r} \geq f$ *and* when $\bar{r} \leq f$. This seemingly non-binding and contradictory condition is, in fact, the basis for distinguishing between hedging and speculative transactions.

Suppose that the expected future rate is higher than the corresponding forward rate ($\bar{r} \geq f$). There are two possible motives for the firm to sell foreign exchange on the forward market, even though it expects the future spot rate to be higher. Firstly, the spread between the rates may not be sufficient to warrant overt speculation against the domestic currency ($\alpha<0$), particularly after considering the costs of forward market transactions. This motive can be ignored, for the firm would be better off setting α equal to zero in this case, because the costs of forward market transactions are a minimum at this point. The second, and more likely motive is that although $\bar{r} \geq f$, the firm may not be too confident of its prediction of the future spot rate. Thus, it may consider it possible that the realized future spot rate falls below the present forward rate. To 'hedge' against this possibility, the firm chooses to sell part of its foreign exchange receipts on the forward market, even though it is below what the firm expects the future spot rate to be. Therefore, it may be concluded that when a firm sells foreign exchange in the forward market even though $\bar{r} \geq f$, it is engaging in hedging.

Conversely, the firm may set α between zero and one when the forward rate is higher than the expected future spot rate ($f \geq \bar{r}$). Clearly, the firm would not select a negative α when $f \geq \bar{r}$ (see equation 2.15). A positive α will be chosen to speculate against the foreign currency. With no transactions costs in the forward market, an α greater than one might have been chosen, its magnitude depending on the spread between the two rates and the confidence attached by the firm to its prediction of the future spot rate, $\bar{r}$. In the presence of such costs, however, the firm may find an α between 0 and 1 to be optimal. The precise value chosen for α will be determined by the spread and confidence considerations mentioned above, and the related transactions costs. Given a level of transactions costs, α will be set closer to 1, the higher the spread and the confidence attached to $\bar{r}$ are.

To summarize, we may say that a choice of α outside the range of zero and one clearly indicates speculative behavior. Within this range, however, the firm may be hedging against exchange risk (if $\bar{r} \geq f$) or speculating against the foreign currency (if $\bar{r} \leq f$).

Another observation relates to the setting of α at 1. In previous literature, it has been assumed that the trader will choose to set α at 1 unless some speculative profit is sought. Given our new definition of speculation, and considering equations 2.8 and 2.16, the conclusion is that we cannot make such a general statement. To set $\alpha=1$, these two equations must be satisfied simultaneously. Because they are independent of each other, satisfying one does not imply that the other is also fulfilled. Thus, α will be set at one only if the marginal cost in production (C_1') happens to equal marginal revenues through the forward rate

$(pf(1-C_2'))$ *and* the expected future spot rate $(p\bar{r})$ at the *same* level of output. A brief inspection of Figure 2.2 reveals that such a situation would arise more by chance than by intention.

The final conclusion from the above analysis is that exchange rate uncertainty can be expected to influence a firm's output and forward transaction decisions. This can be seen by examining the first order condition, equation 2.3. Although the first order condition does not explicitly depend on the firm's utility function, it would be incorrect to conclude from this that its decisions are independent of exchange rate uncertainty. The choice of output and the choice of α are determined jointly by this equation. Both of these, in turn, depend on the utility function of the firm through equations 2.1' and 2.2'.

Marginal Impact of Uncertainty

The preceding analysis can be described as the overall impact of uncertainty, following Jacques Dreze and Franco Modigliani.[19] An equally interesting problem is the marginal impact of uncertainty. Indeed,

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[19] Sandmo, op.cit., p. 67.

the effect of increases in the level of uncertainty is more central to this research than is the effect of the introduction of uncertainty into a world characterized by certainty. The study seeks to examine the effect on trade levels of changing from a pegged exchange rate system to a floating one. Exchange uncertainty existed under both systems, but the transition, it is claimed, resulted in an increase in the level of exchange uncertainty.

In order to investigate the impact of an *increase* in the level of risk, the subjective distribution of r must be changed to reflect the higher level of risk. Several ways to accomplish this exist, but the one adopted in this study is the 'mean-preserving' spread. This method has been shown to be superior to the more commonly used methods such as the mean-variance approach, where the mean and the variance are both increased.[20]

The mean-preserving spread is a way to make a distribution more risky by 'stretching' it while leaving the mean unchanged. This enables the isolation of the effects of increases in risk, and is done by replacing the random variable in the model with a linear transformation of it. Specifically, we replace r by $(\gamma r + \theta)$, imposing the condition that $dE(\gamma r + \theta) = 0$.

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[20] Rothschild, M. and Stiglitz, J.E., "Increasing Risk II: Its Economic Consequences", Journal of Economic Theory, March 1971, pp. 66-84.

This implies that,

$$\frac{d\Theta}{d\gamma} = -\bar{r}$$

We can then differentiate the first order conditions with respect to γ to get:

$$\frac{d}{d\gamma}[U_q] = U_{qq}\frac{dq}{d\gamma} + U_{q\alpha}\frac{d\alpha}{d\gamma} + U_{q\gamma} = 0$$
$$\frac{d}{d\gamma}[U_\alpha] = U_{\alpha q}\frac{dq}{d\gamma} + U_{\alpha\alpha}\frac{d\alpha}{d\gamma} + U_{\alpha\gamma} = 0 \qquad (2.19)$$

From which

$$\frac{d\alpha}{d\gamma} = \frac{U_{\alpha q}U_{q\gamma} - U_{qq}U_{\alpha\gamma}}{U_{qq}U_{\alpha\alpha} - (U_{q\alpha})^2}, \text{ where } U_{ij} = \frac{\partial^2 E[U(\pi)]}{\partial i\, \partial j} \qquad (2.20)$$

The denominator is obviously positive, since it is the determinant of the second order Hessian. Therefore, the sign of $\frac{d\alpha}{d\gamma}$ is the same as the sign of the numerator, which depends on:

$$U_{\alpha q} = E\{U''\pi_\alpha\pi_q + U'\pi_{\alpha q}\} \qquad (2.21)$$

$$U_{q\gamma} = E\{U''\pi_q\pi_\gamma + U'\pi_{q\gamma}\} \qquad (2.22)$$

$$U_{\alpha\alpha} = E\{U''(\pi_\alpha)^2 + U'\pi_{\alpha\alpha}\} < 0 \qquad (2.23)$$

$$U_{\alpha\gamma} = E\{U''\pi_\alpha\pi_\gamma + U'\pi_{\alpha\gamma}\} \qquad (2.24)$$

where,

$$\pi_i \equiv \frac{\partial \pi}{\partial_i}$$

$$\pi_{ij} = \frac{\partial^2 \pi}{\partial i \; \partial j}$$

The profit function is:

$$\pi = \alpha pfq + (1-\alpha)p(\gamma r+\Theta)q - C_1(q) - C_2(\alpha pfq)$$

and the objective function becomes:

$$\underset{q,\alpha}{\text{Max.:}}\; E[U(\pi)] \equiv E\{U[\alpha pfq + (1-\alpha)p(\gamma r+\Theta)q - C_1(q) - C_2(\alpha pfq)]\}$$

This yields the following necessary and sufficient conditions for a maximum:

$$U_q = E\{U'[\alpha pf(1-C_2') + (1-\alpha)p(\gamma r+\Theta) - C_1']\} = 0$$

$$U_\alpha = E\{U'[pfq(1-C_2') - p(\gamma r+\Theta)q]\} = 0$$

$$U_{ii} < 0 \quad \text{and} \quad D' \equiv U_{qq}\, U_{\alpha\alpha} - (U_{q\alpha})^2 > 0$$

We can evaluate the U_{ii}'s defined in equations 2.21-2.24 at the point where $\gamma=1$ and $\theta=0$, and write equation 2.22 as,

$$U_{q\gamma} = E\{U''[(1-\alpha)^2(pr-C_1')(pr-p\bar{r})q] + U'(1-\alpha)(r-\bar{r})p\}$$

after substituting for $pf(1-C_2')$ from equation 2.3.

Obviously, $U_{q\gamma}=0$ when $\alpha=1$. When $\alpha\neq 1$, the second term is negative from equation 2.6. The first term may be re-stated as:

$$E\{U''(1-\alpha)^2(pr-C_1')q[(pr-C_1') + (C_1'-p\bar{r})]\}$$

$$= E\{U''(1-\alpha)^2(pr-C_1')^2q \quad + E\ U''(1-\alpha)^2q(C_1'-p\bar{r})(pr-C_1')\}$$

The first term here is negative since the firm is risk-averse. Also, $(1-\alpha)(C_1'-p\bar{r})$ is negative from equations 2.17 and 2.18. Furthermore, it can be shown that if the firm exhibits decreasing absolute risk aversion, $E\{U''(1-\alpha)(pr-C_1')q\}$ is positive. Absolute risk aversion is defined, following Arrow, as $-U''(\pi)/U'(\pi)$ and denoted as $R_a(\pi) > 0$. Thus, decreasing absolute risk aversion implies that $R_a'(\pi) < 0$.

Following the line of reasoning suggested by Sandmo, let $\bar{\pi}$ be the profit level when $p\bar{r} = C_1'$. Then, with $R_a(\pi) > 0$ and $R_a'(\pi) < 0$, we have,

$$R_a(\pi) \leq R_a(\bar{\pi}) \quad \text{for} \quad pr \geq C_1' \quad \text{and } \alpha < 1,$$

since 'pr' enters the profit function positively only when $\alpha < 1$. In other words,

$$R_a(\pi) \leq R_a(\bar{\pi}) \quad \text{for} \quad (pr-C_1')(1-\alpha) \geq 0$$

Multiplying both sides by $-U'[(pr - C_1')(1-\alpha)]$, we have,

$$U''(pr-C_1')(1-\alpha) \geq -U'R_a(\bar{\pi})(pr-C_1')(1-\alpha)$$

for all 'pr' and α.

Taking expectations of both sides and noting that $R_a(\bar{\pi})$ is a given number,

$$E\{U''(pr-C_1')(1-\alpha)\} \geq -R_a(\bar{\pi})(1-\alpha)E\{U'(pr-C_1')\}$$

The right side is clearly zero from 2.1'.

Therefore, $E\{U''(pr-C_1')(1-\alpha)\} \geq 0$ and we can conclude that

$$U_{q\gamma} \begin{cases} < 0 & \text{for } \alpha \neq 1 \\ = 0 & \text{for } \alpha = 1 \end{cases} \tag{2.25}$$

Similarly,

$$U_{\alpha\gamma} = E\{U''[pfq(1-C_2') - prq][1-\alpha)p(r-\bar{r})q]$$

$$- U'p(r-\bar{r})q\}$$

$$= E\{U''[(C_1'-pr)(1-\alpha)p(r-\bar{r})q^2] - U'p(r-\bar{r})q\}$$

$$= U_{q\gamma} \cdot \frac{q}{(1-\alpha)} \qquad (2.26)$$

$$U_{q\alpha} = E\{U''q(C_1'-pr)(1-\alpha)(pr-C_1') + U'(C_1-pr)$$

$$- U'C_2''\alpha p^2 f^2 q\}$$

$$= E\{-U''q(C_1-pr)^2(1-\alpha) - U'C_2''\alpha p^2 f^2 q \qquad (2.27)$$

since the expectation of the second term is zero.

Lastly,

$$U_{qq} = E\{U''[\alpha pf + (1-\alpha)pr - C_1' - C_2'\alpha pf]^2$$

$$+ U'(-C_2''(\alpha pf)^2 - C_1'')\}$$

$$= E\{U''(1-\alpha)^2(pr-C_1')^2 - U'[C_2''(\alpha pf)^2 + C_1'']\}$$

$$(2.28)$$

Substituting for $U_{\alpha\gamma}$ from 2.26 into 2.20 and rearranging terms, we have

$$\frac{d\alpha}{d\gamma} = \frac{1}{D'}[U_{q\alpha} + U_{qq}\frac{q}{(1-\alpha)}]U_{q\gamma}$$

where $D' = U_{qq}\, U_{\alpha\alpha} - (U_{q\alpha})^2 > 0$

Which upon substitution from 2.27 and 2.28 yields,

$$\frac{d\alpha}{d\gamma} = \frac{1}{D'}\; U_{q\gamma}E\{-U''(1-\alpha)q(pr-C_1')^2 - U'C_2''\alpha p^2 f^2 q$$

$$+ U''(1-\alpha)q(pr-C_1')^2 - \frac{U'q}{(1-\alpha)}[C_1''+C_2''(\alpha pf)^2]\}$$

$$= -\frac{1}{D'}U_{q\gamma}\; E\; U'C_2''\alpha p^2 f^2 q + \frac{U'C_2''}{(1-\alpha)}(\alpha pf)^2 q + \frac{U'qC_1''}{(1-\alpha)}\}$$

$$= -\frac{1}{D'}\frac{U_{q\gamma}}{(1-\alpha)}E\{U'C_2''\alpha p^2 f^2 q + U'qC_1'' - U'C_2''\alpha^2 p^2 f^2 q$$

$$+ U'C_2''(\alpha pf)^2 q\}$$

$$= -\frac{1}{D'}\frac{U_{q\gamma}}{(1-\alpha)}E\{U'q[C_2''\alpha p^2 f^2 + C_1'']\}$$

The term within the brackets {...} can be shown to be positive. The first term, $C_2''\alpha p^2 f^2$ is the negative of the slope of $[pf(1-C_2')]$ with respect to q.

When $\alpha \geq 0$, the slope of $[pf(1-C_2')]$ is non-positive (see Figure 2.1) and thus,

$$C_2''\alpha p^2 f^2 \geq 0$$

From which it follows that

$$C_2''\alpha p^2 f^2 + C_1' > 0$$

On the other hand, when $\alpha < 0$, we can see from Figure 2.1 that

$$-C_2''\alpha p^2 f^2 < C_1''$$

which implies, once again, that

$$C_2'\alpha p^2 f^2 + C_1' > 0$$

Furthermore, it has been shown that

$$U_{q\gamma} \begin{cases} < 0 \text{ for } \alpha \neq 1 \\ = 0 \text{ for } \alpha = 1 \end{cases}$$

$$\frac{U_{q\gamma}}{(\alpha-1)} \begin{cases} < 0 \quad \text{if } \alpha > 1 \\ > 0 \quad \text{if } \alpha < 1 \\ = 0 \quad \text{if } \alpha = 1 \end{cases}$$

We may therefore conclude that,

$$\frac{d\alpha}{d\gamma} \begin{cases} < 0 & \text{if } \alpha > 1 \\ = 0 & \text{if } \alpha = 1 \\ > 0 & \text{if } \alpha < 1 \end{cases} \tag{2.29}$$

In order to solve for $\frac{dq}{d\gamma}$, we need to evaluate $U_{\alpha\alpha}$ at $\gamma=1$, and $\theta=0$.

$$U_{\alpha\alpha} = E\{U''(\pi_{\alpha})^2 + U'\pi_{\alpha\alpha}\}$$

$$= E\{U''(C_1'-pr)^2 q^2 - U'C_2''(pfq)^2\} \tag{2.30}$$

Then, solving for $\frac{dq}{d\gamma}$ from the equations in 2.19,

$$\frac{dq}{d\gamma} = \frac{1}{D'} [U_{\alpha\gamma}U_{q\alpha} - U_{\alpha\alpha}U_{q\gamma}]$$

and substituting for $U_{\alpha\gamma}$ from 2.26 we have,

$$\frac{dq}{d\gamma} = \frac{1}{D'} [-U_{q\gamma} \frac{q}{(1-\alpha)} U_{q\alpha} - U_{\alpha\alpha}U_{q\gamma}]$$

$$= - \frac{q}{D'} \frac{U_{q\gamma}}{(1-\alpha)} [U_{q\alpha} + U_{\alpha\alpha} \frac{(1-\alpha)}{q}]$$

Finally, substituting for $U_{q\alpha}$ and $U_{\alpha\alpha}$ from 2.27 and 2.30, respectively,

$$\frac{dq}{d\gamma} = -\frac{1}{D'}\frac{q}{(1-\alpha)}U_{q\gamma}\{E[-U''(C_1'-pr)^2(1-\alpha)q - U'C_2''\alpha p^2f^2q]$$

$$+ E[U''(C_1'-pr)^2(1-\alpha)q - U'C_2''(pfq)^2\frac{(1-\alpha)}{q}]\}$$

$$= -\frac{1}{D'}\frac{q}{(1-\alpha)}U_{q\gamma}\{-E[U'C_2''\alpha p^2f^2q + U'C_2''p^2f^2q$$

$$- U'C_2''\alpha p^2f^2q]\}$$

$$= \frac{1}{D'}\frac{q}{(1-\alpha)}U_{q\gamma}E[U'C_2''p^2f^2q]$$

The term in brackets is positive as shown earlier, and $U_{q\gamma}$ was shown to be negative when $\alpha \neq 1$, and equal to zero when $\alpha = 1$. Hence, we can conclude that,

$$\frac{dq}{d\gamma}\begin{cases} > 0 & \text{if } \alpha > 1 \\ < 0 & \text{if } \alpha < 1 \\ = 0 & \text{if } \alpha = 1 \end{cases} \qquad (2.31)$$

The results contained in equations 2.29 and 2.31 are summarized in Table 2.1, for the four distinct regions of α.

Table 2.1

Effect of Increased Exchange Uncertainty On Output and Forward Market Transactions.

	$\alpha<0$	$0\leq\alpha<1$	$\alpha=1$	$\alpha>1$
Output	decreases	decreases	unchanged	increases
Forward market transactions	decrease	increase	unchanged	decrease

The four cases are now examined separately to illustrate the rationality of these decisions.

CASE 1: $\alpha<0$

When α is set at less than zero, the firm is overtly speculating against the domestic currency, since it expects the future spot rate to be higher than the present forward rate. (Because of the way exchange rate is defined, a higher rate for domestic currency means it is devalued.) The firm contracts to buy foreign exchange through the forward market in the expectation of a speculative profit. This transaction is against the direction indicated by the export transaction. The export earnings are left totally uncovered. When the export earnings are received and the forward contract becomes due (simultaneously, by assumption), the firm will sell the foreign exchange in the future spot market. We can, therefore, identify the marginal profit from the export transaction to be

$$p\bar{r} - C_1' > 0 \tag{2.32}$$

from equation 2.17. The marginal profit from the speculative transaction can be stated as

$$p\bar{r} - pf(1-C_2') > 0 \tag{2.33}$$

from equation 2.9. In the absence of uncertainty, production and speculation would both be increased to the point where these two inequalities became equalities. Therefore, the lower levels of both transaction implied by 2.32 and 2.33 can be unambiguously ascribed to the presence of uncertainty surrounding the future spot rate. When the level of uncertainty increases, production and speculation are reduced, per Table 2.1, column 1. Such a reduction increases the spreads in 2.32 and 2.33 by reducing the marginal costs in both cases. Since $p\bar{r}$ is unchanged, it is clear that the firm responds to the increased level of uncertainty by demanding a larger marginal profit. This is, of course, characteristic of risk-averse behavior.

In terms of Figure 2.3 (shown as Figure 2.2 earlier), the firm moves from a point such as A to a point below, say B.

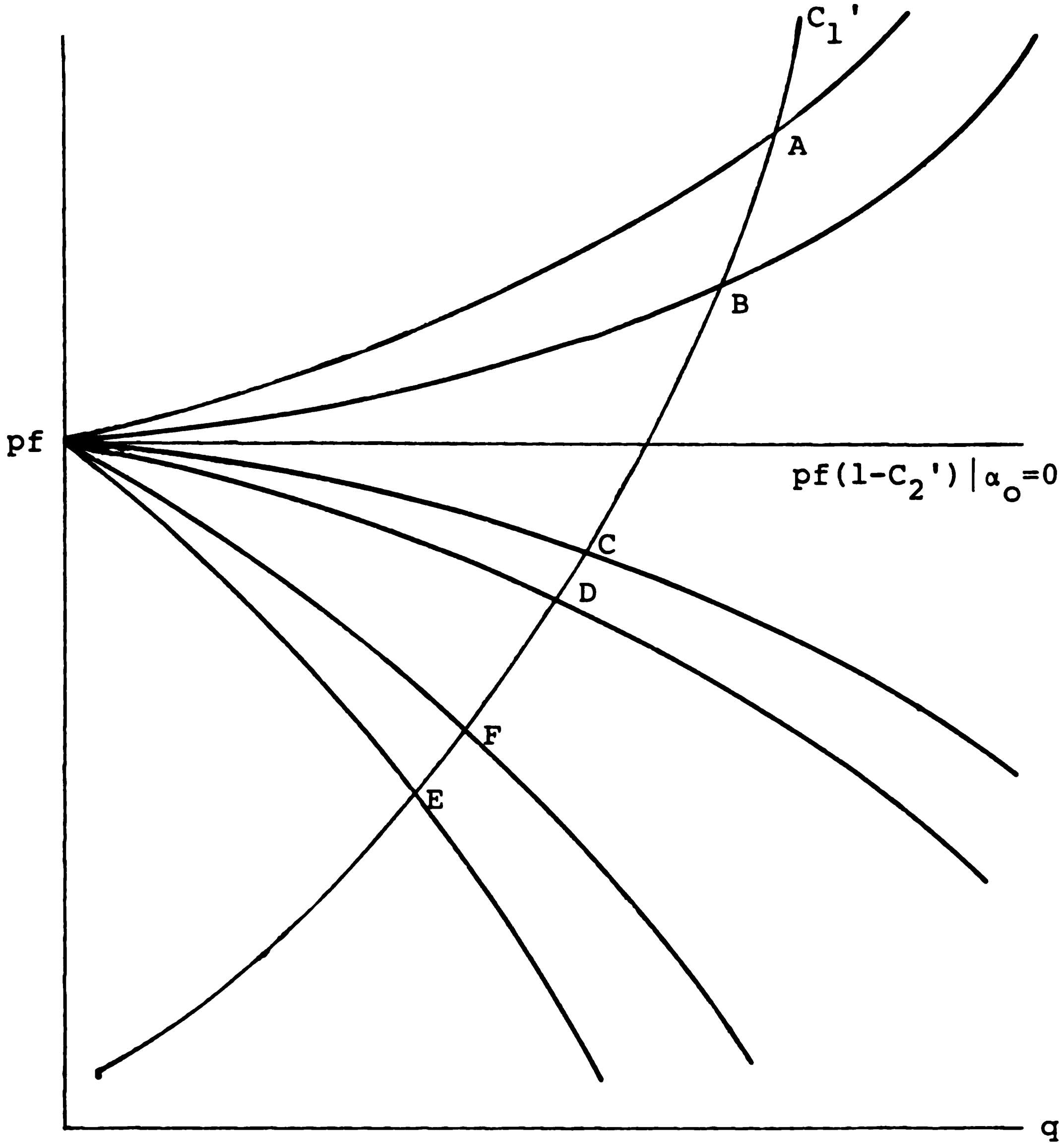

Figure 2.3

Expected Future Spot Rates and Optimal Production and Hedging

CASE 2: $0 \leq \alpha < 1$

As explained earlier, the firm may set α in this range for speculative purposes (if $f \geq \overline{r}$) or for hedging purposes (if $f \leq \overline{r}$). These two cases can be analyzed separately.

First, suppose that $f \geq \overline{r}$, so that the firm is speculating against the foreign currency. In other words, the firm would cover foreign exchange earnings from the export transaction, but because it seeks speculative profit, it leaves a part of its foreign exchange receipts uncovered for purely speculative purposes. We may depict this situation by identifying the marginal profit from the export transaction (with $\alpha=1$) to be

$$C_1' - pf(1-C_2') = 0 \tag{2.34}$$

by equation 2.3. This equality is understandable since no uncertainty is involved in this transaction.

The marginal profit from the speculative transaction (i.e. leaving the $(1-\alpha)$th unit of foreign exchange uncovered) is

$$p\overline{r} - pf(1-C_2') \tag{2.35}$$

which is positive from equation 2.9. According to Table 2.1, the firm reduces both output and exports in the face of increased uncertainty in this case. An examination of these two marginal conditions reveals that such behavior is in keeping with risk-averseness.

Faced with a less certain future spot rate, the firm seeks to increase the spread in equation 2.35. This it does by reducing the level of speculation (i.e. by increasing α). No sooner is this done, however, than the equality in 2.34 is disturbed. Specifically, the net marginal revenue from the forward market declines. The firm, therefore, reduces output to restore the equality between the marginal cost, and marginal revenue of its export transaction.[21]

Conversely, suppose the firm chose an α in this range in order to hedge against exchange risk. We may then specify its marginal export condition as

$$p\bar{r} - C_1' > 0 \qquad (2.36)$$

since the only reason for selling foreign exchange in the forward market was to reduce the level of exposure to exchange uncertainty. By equation 2.17, this value is positive. As before, it can be argued that the lower level of output implied by 2.36 as compared to the decision rule under certainty ($p\bar{r} = C_1'$), is due

[21]It should be pointed out that since C_2' is determined jointly by q and α, the restoration of equilibrium involves a series of iterations. But because the final direction of change in these two variables is known, the process is described in this and following discussions as a single iteration adjustment, without affecting the conclusions.

to the uncertain future spot rate. Hence, the firm is reducing exposure to exchange rate partly by reducing output, and partly by hedging.

The premium (at the margin) paid by the firm to reduce exposure through hedging is specified by

$$pf(1-C_2') \quad - \quad p\bar{r} \quad < \quad 0 \qquad (2.37)$$

which is negative per equation 2.9. An increase in the uncertainty surrounding the future spot rate would cause the firm to seek a higher level of cover since it is risk-averse. Such an action increases the spread in equation 2.37, increasing the premium. Clearly, the firm is willing to pay a higher premium to hedge against the higher level of exchange risk involved.

Simultaneously, the firm is able to reduce exchange exposure by reducing output, thereby increasing the spread in 2.36. These changes are consistent with risk-averse behavior, as specified in Table 2 (column 2), and depicted in Figure 2.3 as a movement from C to D.

CASE 3: $\alpha=1$

As pointed out earlier, the choice of an α of unity will be a rare occurrence, since two unrelated conditions need to be satisfied at this point. Simultaneous satisfaction of these two conditions (equations 2.8 and 2.16) would occur more by chance than by intention. When such an α is selected, however, the firm totally covers its foreign exchange earnings, and assumes a neutral speculative stance. No uncertainty surrounds the export transaction in this case. Thus, the firm produces at a point where its marginal cost of production exactly equal its net marginal revenue from the forward market. That is,

$$pf(1-C_2') = C_1' \tag{2.38}$$

defines the firm's production decision. Clearly, a change in the level of exchange rate uncertainty effects neither side of 2.38. Thus, no output changes would result, which is consistent with Table 2 (column 3).

CASE 4: $\alpha > 1$

In this situation, the firm is speculating overtly against the foreign currency. It expects the future spot rate for domestic currency to be lower (i.e. the foreign currency to devalue) than the present forward rate--see equation 2.13. The firm enters into a forward contract to sell its entire foreign exchange receipts from the export transaction. In addition, the firm assumes a long position in forward foreign exchange in anticipation of a speculative profit.

Here, the output decision is being made by equating the marginal costs and marginal revenues from the forward market

$$C_1' = pf(1-C_2') \qquad (2.39)$$

The speculative transaction, on the other hand, yields the following marginal profit

$$pf(1-C_2') - p\bar{r} > 0 \qquad (2.40)$$

which is positive from equation 2.10. Following earlier analysis, we can examine the firm's actions if uncertainty increases. When this happens, the marginal costs of the speculative transaction is subject to greater risk. Therefore, a risk-averse firm would seek to increase the spread in 2.40. This it does by reducing α, which reduces the value of C_2'. No sooner is this done, however, than the equality in 2.39 is disturbed since the marginal revenue from production is now higher. The firm increases its output in order to restore equilibrium in its export transaction. Clearly, the directions of change outlined in this case also conform with risk-averse behavior, and are consistent with the results stated in Table 2 (column 4), shown in Figure 2.3 as a movement from E to F.

CONCLUSIONS

The following observations summarize the findings of this chapter.

1) When the choice of α is unrestricted, it is not possible to unambiguously predict the effect of increased exchange uncertainty on the level of exports. The result is dependent on the range in which α was set prior to the increase in uncertainty. Output and exports will decline if α had been below one. However, if the firm is reasonably confident that the foreign currency will depreciate and the spread between the forward and future spot rate is large enough, α may be set at greater than one. In this case, the firm's exports can be expected to increase. If a large number of exporters in a country share these expectations, it may well transpire that such a country's exports would rise in the face of increased uncertainty.

2) In most developing countries overt speculation is prohibited. This has the effect of restricting α to the closed interval between zero and one. In such a situation, it can be unambiguously predicted that exports

will decline in the face of increased exchange rate uncertainty.[22]

The results are, it should be noted, contingent on the presence of significant costs associated with forward market transactions. If these costs do not exist or are insignificant, then Ethier's conclusions apply--i.e. exchange risk will not effect export levels.[23] It has been argued here that in developing countries forward market costs cannot be ignored, justifying the present analysis.

The next step in this research is to model the export sector of a developing country. This is done in Chapter 3. Then exchange risk is specified in an empirically measurable way in Chapter 4, which also examines the question whether exchange risk so defined has in fact increased since the inception of floating rates in 1973.

Before we turn our attention to these issues, one final observation needs to be made concerning the question of forward market costs. While it is commonly assumed that exchange markets in developed nations are so

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[22]If $\alpha=1$, output would not change. But, even if a few firms set $\alpha=1$, the probability of which it has been earlier is rather small, it is extremely unlikely that all firms in a particular country would simultaneously set α at this level. Therefore, when exporters in a country are considered in the aggregate, this case can be ignored.

[23]Ethier, op.cit., p 496.

nearly perfect that such costs are insignificant, this position is not totally unquestionable. For instance, the European Joint Float serves to minimize exchange uncertainty between member countries. This would not have been necessary if financial markets were perfect. In addition, at a meeting of the Bank for International Settlements in 1978, officials expressed serious concern that the volatility of the U.S. dollar has had a "negative influence on business decisions."[24] Such concerns provide circumstantial, though not conclusive, evidence that exchange rate uncertainty is a pertinent factor in trade decisions, even in countries that have well-developed financial and exchange markets. Therefore, the results of this investigation may be more generalizable than is contended here.

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[24] Zijlstra, Jelle, Netherlands Central Bank Chief and BIS Chief, as quoted in the Wall Street Journal, June 13, 1978, p. 13.

CHAPTER 3

THE MODELS OF THE EXPORT MARKET

In this chapter, the export market for a developing country is modeled. The relationship between exchange rate uncertainty and the level of exports is then explained in the context of the models of the export sector. In the first model, the aggregate exports of a country are considered, whereas the second approach models the bilateral export markets. Building on the analysis contained in this chapter, the models are translated into empirically testable form in Chapter 5, which essentially deals with the empirical portion of this study.

The Export Market in a Developing Country

Before the question of exchange uncertainty is incorporated in the discussion, it would be instructive and simpler to develop the models of export supply and the demand for exports by the importing countries excluding the uncertainty question. This simplification is particularly beneficial because the export supply and demand for export functions differ somewhat from traditional ones, in order to account for the special circumstances pertaining to the export markets in the developing countries. These have been receiving increased attention in the literature.

Traditionally, the export supply function is viewed as an excess supply function, the underlying assumption being that a domestic market also exists for the good that is being exported. In this case, export supply is really a residual between the domestic supply and domestic demand for the good in question. The export supply function would then include the variables in the domestic supply as well as domestic demand functions. Under this approach, the price elasticity of export supply would be a weighted average of the domestic demand and supply elasticities.[25]

It has been argued that this approach is not suitable for developing countries for two reasons. First, the export bundle is likely to be vastly different from the bundle of goods consumed domestically. Demand patterns and tastes in the export markets (generally the industrial nations) differ substantially from those of the domestic markets.

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[25]Kreinin, M., International Economics: A Policy Approach, 3rd ed., p. 445 (NYC, NY; Harcourt, Brace Janovich, 1979)

Secondly, the export sector in developing countries is typically not well integrated with the rest of the economy. For these two reasons, it is claimed, the specification of an export supply function as an excess supply function would be erroneous. Instead, a pure supply function is recommended, totally independent of the domestic demand variables.[26]

While the observations concerning the developing countries are by and large accurate, it is not clear whether the use of an export supply function totally independent of domestic demand is justified on these grounds alone. However segregated the export sector may be, it must still compete with the domestic sector for productive resources. And domestic demand variables can and will influence this allocation of resources. For instance, if domestic prices rise, production for the domestic market becomes relatively more profitable. Resources will shift to domestic production as a consequence, reducing the output of exportable goods. Clearly, other domestic demand variables will also influence export supply, albeit not in as direct a manner as implied by the use of an excess supply function.

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[26]See Grossman, G.M., "A Quarterly Econometric Model of the Exporting Behaviour of Some Nonindustrial Countries", unpublished manuscript, M.I.T., 1978.

It may be concluded from the above discussion that although it is correct to view the export supply function of a developing country as a pure supply function, certain domestic demand variables must also be included in the formulation. Accordingly, the export supply function employed in this study is specified as:

$$X_i^S = X_i^S \, (P_{x_i}, P_{d_i}, Y_i) \tag{3.1}$$

where,

X_i^S is the exports supplied by country i.

P_{x_i} is the price index for export.

P_{d_i} is the domestic price index, entering (1) as a scale variable.

Y_i is an index of domestic productive capacity. It is also a scale variable, included on the assumption that as a country's capacity to produce rises, so will exports, ceteris paribus.[27]

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[27] Grossman, G.M., op.cit., criticizes the use of Y in the export supply function in this manner. The reason being that supply is determined by prime costs. Grossman, therefore, uses wage rates instead. Again, the reasoning is correct, but his solution does not seem appropriate. Wages are just one component of prime costs. Data on these costs are not available, however, and hence the use of wages alone. There is little reason to believe that changes in wages

The world demand for a country's exports is assumed to be perfectly elastic.[28] This assumption is justified so long as the exports of the country are being studied do not represent a significant portion of total world exports of commodities involved. A perfectly elastic demand for export is the equivalent of a perfectly elastic supply function which is commonly assumed for a small importing country.[29]

Under the small country assumption, the export price is exogenously determined in the markets of the importing countries. The exporting country cannot influence this price and simply adjusts supply in keeping with the exogenously determined price.

The effect of exchange rate uncertainty on the level of exports can now be illustrated. Figure 3.1

27(contd.)

accurately reflect changes in overall prime costs. Therefore, in the present study, the use of Y is preferred, especially because it has yielded tolerably good statistical fits in the past. See Goldstein, M. and Khan, M.S., "The Supply and Demand for Exports: A Simultaneous Approach", RESTAT, March 1977, pp. 275-286. Admittedly, this is not a satisfactory solution, but is one necessitated by data considerations.

28 For an alternative formulation, dropping the small country assumption, see Appendix 3.

29 The proof of the present proposition is also similar, and one can be found in Kreinin, M., op.cit., p. 445.

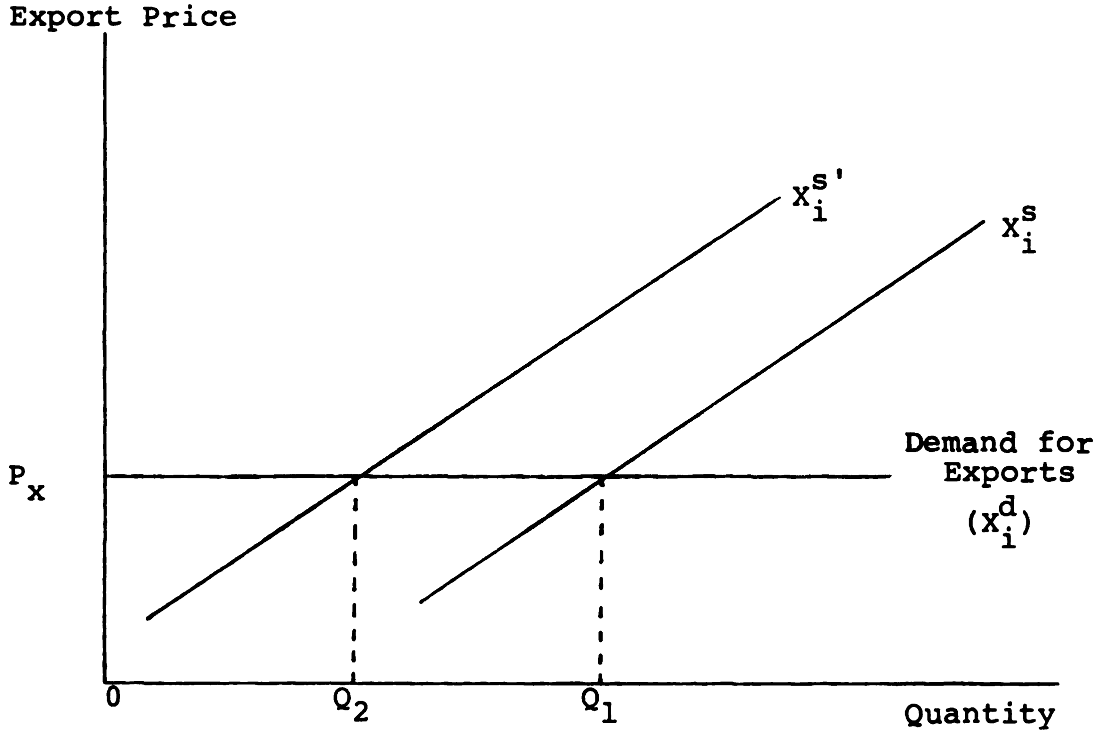

Figure 3.1

The Export Market for
a Developing Country

shows the export market of a small country, as described above. If exchange rate uncertainty reduces exports, as the developing countries have claimed, it can be incorporated into the model by specifying the export supply function as follows:

$$X_i^s = X_i^s \; (P_{x_i}, P_{d_i}, Y_i, R_i) \tag{3.2}$$

where all the variables are as defined earlier, and R_i is a proxy for exchange rate uncertainty for country i.

In terms of Figure 3.1, the effect of an increase in exchange uncertainty is depicted by a leftward shift in the export supply function (from X_i^s to $X_i^{s'}$). As a result of the increase in the level of exchange uncertainty, exports decline from OQ_1 to OQ_2, at an unchanged export price of P_x.

It should be noted that for some commodities such as oil, exporting countries are able to exert considerable power in the export market. In such cases, the small country assumption would not be appropriate, especially since the exports of such countries are highly concentrated in these commodities. By and large, the countries being studied here (Mexico, Israel, Taiwan, India and Korea) do not possess monopoly power in any single commodity market, and therefore, the small country assumption is justified. In addition, aggregate exports are being considered, so that whatever little market power may exist in a particular commodity, it is sufficiently diluted to pose no serious problem.

A second approach used in this study to test for the effect of exchange risk on developing countries' ability to export examines structural shifts in their bilateral export supply functions. This test applies only to those countries that did not change their exchange rate practices when the managed float became operative in 1973. Thus, Mexico, Taiwan and Korea are the three countries for which this test is used. India and Israel both changed their pegging practices during the past six years.

Without loss of generality, consider a developing country, A, whose currency is pegged to the U.S. dollar. Bearing in mind that after March 1973, the U.S. dollar was floating against all other major currencies, it is easy to see that the changes in the level of uncertainty influencing A's exports to the U.S.A. and to all other countries would be asymmetrical. By way of illustration, we write A's exchange rate vis-a-vis country i (other than the U.S.A.) as:

$$r_i = r_c * r_i^c \qquad (3.3)$$

where,

r_i is A's exchange rate in units of currency i.

r_c is A's exchange rate in units of U.S. \$.

r_i^c is the exchange rate of the U.S. \$ in units of currency i.

Under the adjustable peg system, both r_c and r_i^c were officially pegged rates, allowed to fluctuate within a small band (4 1/2% since 1971) around this central rate. With the change in the monetary system, r_i^c became a floating rate, and its increased volatility would be transmitted directly to r_i through the still pegged r_c. Consequently, the uncertainty associated with A's exports to the U.S.A. would be less than that associated with its exports to other countries. In other words, if the developing country claim is correct, we should observe a structural shift in exports away from other countries towards the U.S.A. The important point to note is that this structural shift takes place independent of the level of uncertainty surrounding exports to the U.S.A. With the introduction of managed floats, uncertainty in exports to the U.S.A. may have also increased. The structural shift would still occur because the *relative* level of uncertainty has become lower for exports to the U.S.A.

This observation forges the link between the two tests used in this study, and also explains why the second test is non-trivial. Suppose it is found that the aggregate exports of country A have not declined significantly in the face of increased uncertainty. The aggregate analysis may conceal a structural shift which the second test would reveal. With the existing pressure on businessmen in developing countries to export, they may have responded to the increased uncertainty by diverting their exports to the less uncertain market (i.e. the U.S.A.) in lieu of reducing the overall level of exports. On the other hand, if aggregate exports were found to be dampened due to increased uncertainty, the issues raised in the second test would still be interesting. Developing countries, have, over the last two decades or so, made considerable progress towards diversifying their exports, thereby reducing their historic dependence on a single market. A structural shift in exports to the center country implies that this geographical diversification effort would be thwarted--something that is perceived to be a serious impediment to continued progress in the developing countries.

Figures 3.2(a) and (b) depict the situation in terms of bilateral export supply functions. In the first, the bilateral export supply function from the developing country to its center country shifts to the right (X_c^s to $X_c^{s'}$), whereas it shifts to the left for other countries (X_o^s to $X_o^{s'}$). Figure 3.2(b) shows the other possibility, where both functions shift to the left, but the shift is significantly smaller for the center country.

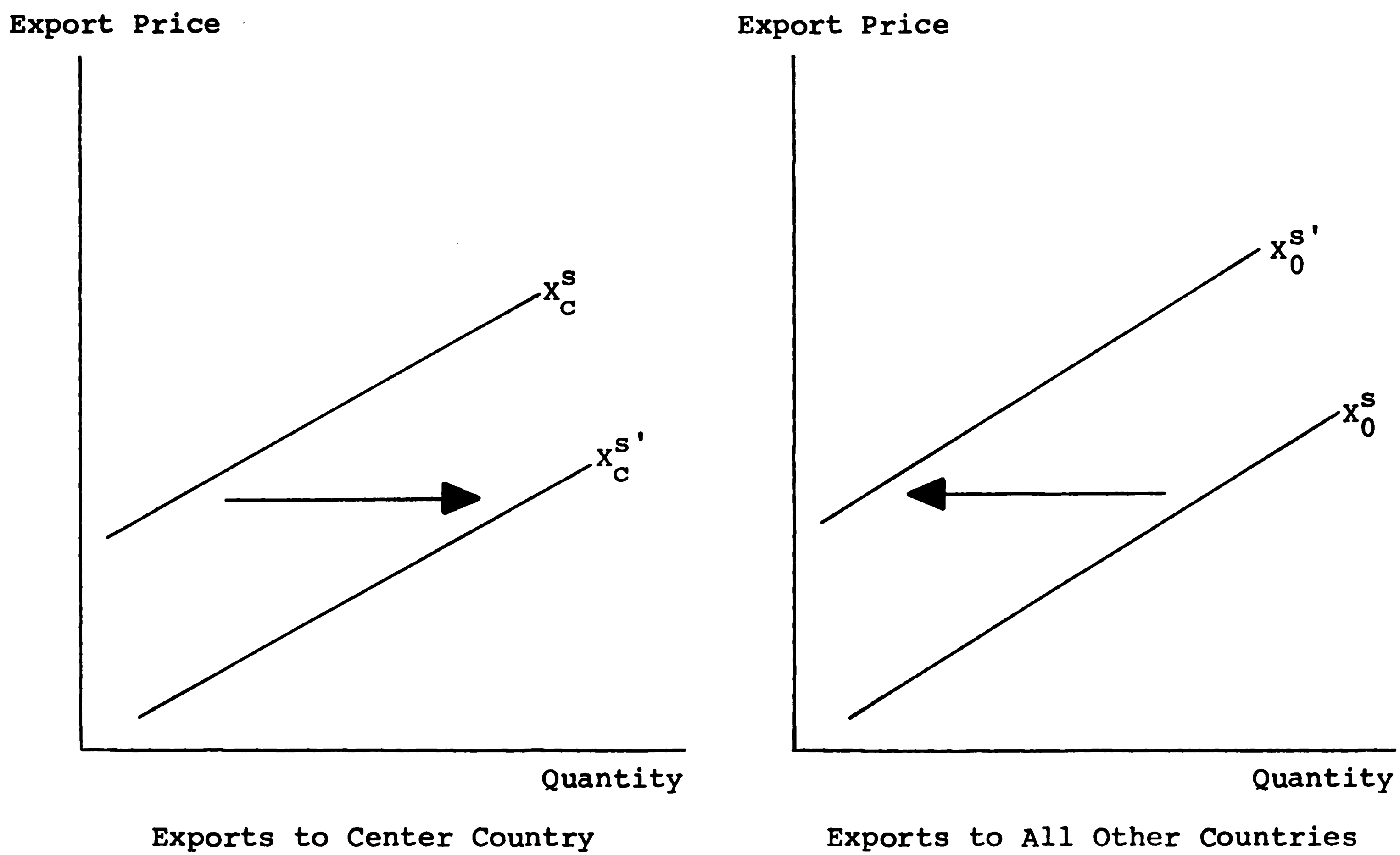

Figure 3.2a

Bilateral Exports of a Developing Country

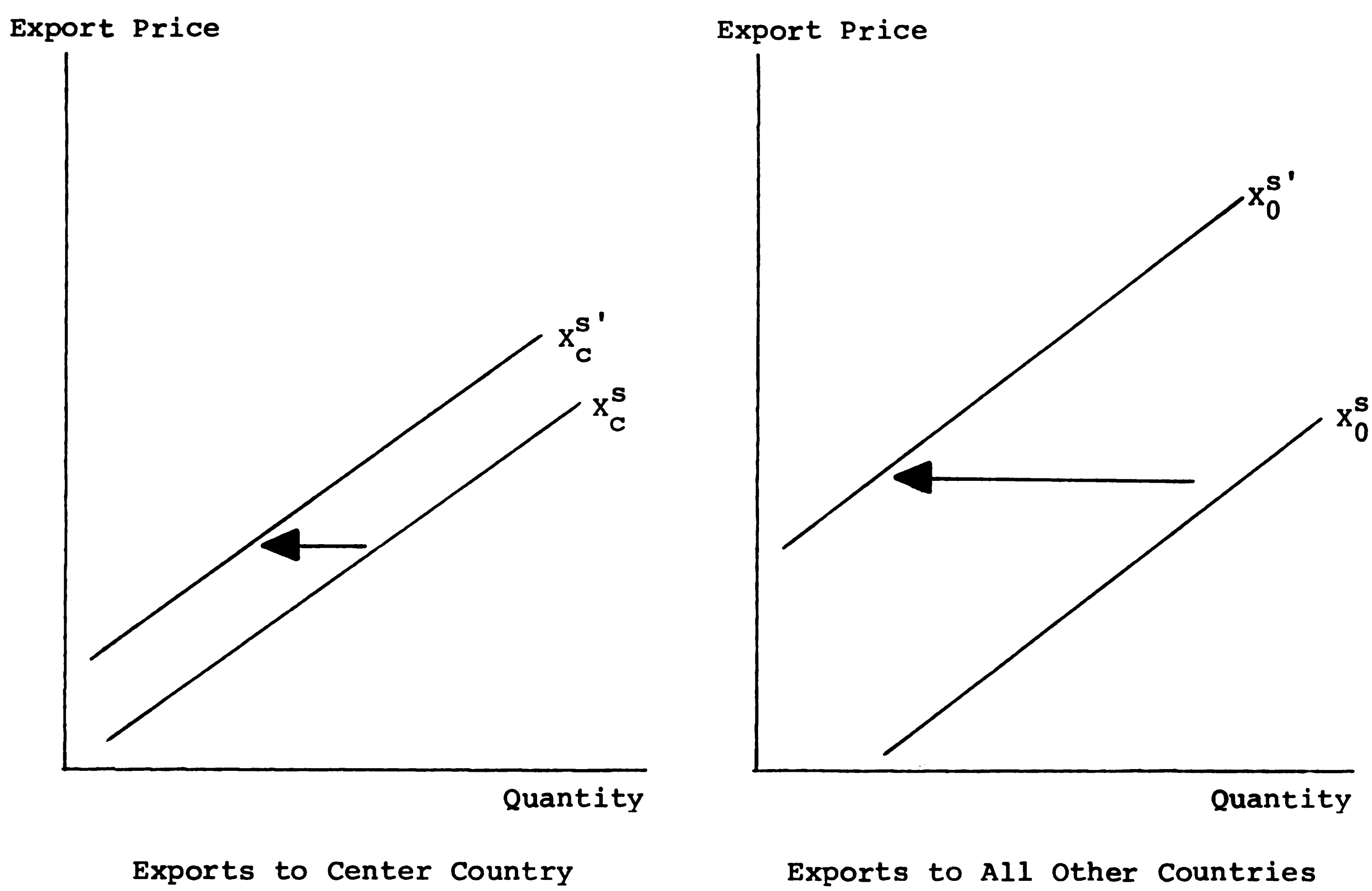

Figure 3.2b

Bilateral Exports of a Developing Country

To examine this hypothesis empirically, the bilateral exports of country i to country j are specified as,

$$X_{ij}^{s} = X_{ij}^{s}\ (P_{x_i}, P_{d_i},\ Y_i,\ D) \qquad (3.4)$$

where,

X_{ij}^{s} = exports of country i to country j.

j = 1 for exports to the center country, and
 = 2,..,n for exports to other countries.

D = dummy variable to account for the change in the exchange rate system in March 1973. D is set at zero for periods prior to 1973 (Qtr 2) and to one for subsequent periods.

Other variables are as defined earlier. Invoking the small country assumption, we can ignore demand considerations.[30] If it is true that uncertainty has affected exports, then the coefficient of the dummy variable should be larger for the center country (j=1) than for exports to the other countries ($j\neq 1$).

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[30]The assumption is justified where i's exports to j are a small fraction of j's global imports for each commodity. The proof is straightforward, and one can be found in Appendix 2. Obviously, the small country assumption is less tenable for bilateral exports than it is for aggregate exports. Therefore, the supply functions are also estimated in a simultaneous model (see below).

Whether or not the small country assumption is appropriate when considering bilateral exports is very much an open question. The choice is bound to be arbitrary, since there is seldom any unambiguous criteria on which the decision can be based. Therefore, in this study, the small country assumption is later dropped and the export supply function is re-estimated as part of a simultaneous equation system. A close correspondence between the two sets of results would suggest that the small country assumption is valid. A definitive answer is not expected, but it is felt that this procedure would provide useful information for judging when a small country assumption is appropriate.

In the simultaneous approach, the equations in 3.4 are combined with corresponding bilateral demand for export functions of several (four or five of the largest trading partners) countries for country i's exports. The entire system is presented below:

$$X^s_{ij} = X^s_{ij}\ (P_{x_i},\ P_{d_i},\ Y_i,\ D) \qquad (3.4)$$

$$X^d_{ij} = X^d_{ij}\ (P_{x_i},\ P_{d_j},\ Y_j,\ P_{x_w}) \qquad (3.5)$$

where,

X^{d}_{ij} = the demand by country j for country i's exports.

P_{d_j} = the domestic price index in country j.

Y_j = an index of real income in country j.

P_{x_w} = the world export price index. A bias is introduced in this index due to the inclusion of country i's export prices, but this bias is deemed negligible. Of the countries being studied, none exports a significantly large fraction of total world exports.

All other variables have been defined earlier. The estimation is conducted under the assumption that the export markets are in equilibrium,

$$\text{i.e.} \quad X^{s}_{ij} = X^{d}_{ij} \qquad (3.6)$$

The next chapter develops a proxy for exchange risk, and presents the empirical results of its measurement under pegged and floating exchange rates. The computed values of the exchange risk variable are then used in the empirical tests of the hypothesis that exchange rate uncertainty has dampened the exports of the five countries being examined. This is the subject of Chapter 5.

CHAPTER 4

THE MEASUREMENT OF EXCHANGE RISK UNDER ALTERNATIVE EXCHANGE REGIMES

The question of exchange rate uncertainty has received considerable attention in the past, since it is one of the central issues in the broader debate concerning the merits of alternative exchange regimes.[31] While the particular arguments in the debate are not central to the present research, one consequence of this ongoing debate which is of interest here is that considerable light has been shed on the otherwise complex concept of exchange rate uncertainty. As can be expected, research interest in this concept has been rekindled since floating rates became the dominant exchange policy internationally in 1973. It

[31]Opponents of flexible exchange rates have contended that the question of exchange rate instability is one of the most serious criticisms of the freely floating exchange rate system. For a review of the issues and the arguments on both sides, see Friedman, M., "The Case for Flexible Exchange Rates", in Caves, R.E. & Johnson, H., eds., Readings in International Economics, Chapter 25 (Homewood, Ill; Richard D. Irwin, Inc., 1969); Morgan, E.V., "Theory of Flexible Exchange Rates", AER, June 1955; Sohmen, E., "Flexible Exchange Rates, (Chicago, Ill; U of Chicago Press, 1969); Kreinin, M.E., op.cit., Chapter 10; Caves,

would be instructive to separate and categorize the various views on this subject (i.e. what the appropriate proxy for exchange uncertainty is), in order to clearly understand current thinking.

Historically, attention has been focused on the exchange volatility of spot exchange rates. In fact, earlier discussion almost exclusively centered around exchange rate volatility. The question was whether speculation under freely floating rates would stabilize or destabilize exchange rates.[32] Consequently, the variance or standard deviation of the spot rate were given prominence as the preferred proxies for exchange uncertainty. This traditional interest in exchange volatility lingers on today, and has recently been employed in empirical tests of exchange risk under the present monetary system.[33]

31(contd.)

R.E., "Flexible Exchange Rates", AER, May 1963; Liu, Ta-Chung, "The Elasticity of U.S. Import Demand: A Theoretical & Empirical Reappraisal", IMF Staff Papers, February 1954; Lanyi, A., "The Case for Floating Exchange Rates Reconsidered", Essays in International Finance # 72, (Princeton, N.J.; Princeton U., 1969); Black, S., "Exchange Policies for Developing Countries in a World of Floating Rates", Essays in International Finance # 119, (Princeton, N.J.; Princeton U., 1976).

32 Friedman, M., op.cit., p. 426.

33 Cline, W., International Monetary Reform and the Developing Countries, pp. 17-19 (Washington, D.C.; Brookings Institution, 1975) and Hooper, P. & Kohlhagen, S.W., op.cit., are examples of recent research employing exchange volatility measures.

Following essentially the same line of reasoning, Suss[34] develops a series of proxies for exchange rate uncertainty--deviations of spot rates from moving averages, percentage changes in these deviations, and so on. These measures are then used to examine exchange rate volatility (or variability) under the IMF and the managed float system for eight industrial nations. Her conclusion was that volatility had increased in terms of all the measures since 1973.

The main criticism of these approaches is that they imply an equivalence between exchange rate volatility and exchange rate uncertainty. Such a premise totally ignores the role of expectations. Expectations of future spot rates are crucial when exchange risk is discussed, and cannot therefore be ignored. It is the deviations of expectations from realized future spot rates that are the essence of exchange uncertainty. If expectations are always realized, no uncertainty can be said to exist. For instance, under a system of immutably fixed rates, expectations of future spot rates would always equal existing rates, and will therefore always be realized. No exchange uncertainty exists in this situation. Only when the future spot

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[34] Suss, E., "The Variability of Exchange Rates Under Alternative Regimes", unpublished manuscript, IMF, December 1976.

rate cannot be predicted with unerring accuracy does the question of exchange uncertainty arise.[35]

One situation where variance can be equated with uncertainty is where the underlying attitude towards risk is assumed to be represented by a quadratic utility function, as Clark has assumed.[36] Earlier it was pointed out that such a utility function violates the widely accepted concept of decreasing absolute risk aversion. In view of this, equating variance with uncertainty on this ground is not considered an acceptable rationale.

Farber, et. al.[37] used a different approach to investigate the issue of exchange risk under the two exchange regimes. Their research indicated that

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[35] Interestingly enough, Hooper, P. and Kohlhagen, S.W., op.cit., conduct various tests of exchange rate uncertainty under the assumption that traders' expectations of future exchange rates are always realized. Clearly, such an approach leaves no scope for exchange uncertainty, though the authors contend that it does (see pp. A2 and F5).

[36] Clark, P., "Uncertainty, Exchange Risk & the Level of International Trade", Western Economic Journal, September 1973, pp. 302-313.

[37] Farber, A., Roll, R., & Solnik, B., "An Empirical Study of Risk Under Fixed and Floating Exchange", Journal of Monetary Economics, pp. 235-265, supplementary series, 1977.

the standard deviations of exchange rates had increased in the floating period. However, they found that the distributions had changed in other ways as well. For instance, kurtosis was measured at a significantly higher level under the fixed rates than under floating rates. In both cases, kurtosis was significantly different from 3.0, indicating a non-normal distribution. Intuitively, the higher kurtosis in the fixed period implies that in this period the probabilities of extreme changes were larger. This is in keeping with the nature of the adjustable par system, in which currencies' values are changed by relatively larger amounts and less frequently than under floating rates.

This finding raises the question of what is perceived to be more risky--a sequence of rather small changes as in the floating system, or a sequence of even smaller changes interspersed with larger changes as in the pegged rate period--by all investors considered together. To resolve this issue, the authors attempted to establish first order stochastic dominance of one sample distribution over the other.[38] Such a result would have satisfactorily dealt with the

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[38] Ibid., pp. 248-249.

criticism presented earlier of equating volatility with uncertainty--simply because of the way stochastic dominance is defined. However, their results were largely inconclusive, the dominance statistic not being significantly different from 50 percent in the majority of the cases.[39]

In an attempt to incorporate expectations into his measure of uncertainty, Ginman[40] uses a variation of the Hicksian concept of elasticity of expectations. Specifically, he defines a coefficient of expectations, γ, as his proxy for uncertainty based on the following relationship,

$$r_t^* - r_{t-1}^* = \gamma(r_t - r_{t-1}^*) \quad 0 \leq \gamma < 1 \tag{4.1}$$

where r_t is the exchange rate in time t and the asterisks indicate expected values.

As it stands, γ can be easily recognized as the adjustment coefficient in an adaptive expectations model.[41] This approach has been criticized on the

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[39] Ibid., pp. 250-251.

[40] Ginman, P., The Relative Effects of Uncertainty on Import Volume Under Flexible and Pegged Exchange Rates: The Canadian Experience 1951-1964, unpublished doctoral dissertation, Michigan State University, E. Lansing, MI., 1969.

[41] Madala, G.S., Econometrics, p. 144 (New York, NY; McGraw Hill, 1977).

grounds that γ is really not a reasonable measure of uncertainty.[42]

The essential element of exchange risk, as argued earlier, is the inability forecast exchange rates accurately. The more inaccurate the forecasts are, the higher the perception of uncertainty will be. Thus, exchange risk can best be described in terms of past forecasting experience, i.e. the accuracy with which forecasts were made in the past. Where the inaccuracy of forecasts in the immediate past has increased, exporters would be hesitant to make commitments on the basis of present forecasts, simply because they will have less confidence in the reliability of these forecasts.

Similar approaches have been used in other investigations of exchange risk under floating rates. Aliber,[43] in studying the question of transactions costs and risks associated with floating exchange rates in eight industrial countries, uses the mean absolute difference between predicted and spot rates. He uses the forward exchange rates as his proxy for predicted rates, under the assumption

[42] Clark, P., op.cit., p. 303.

[43] Aliber, R.Z., "The Firm Under Pegged and Floating Exchange Rates", Scandinavian Journal of Economics, #2, 1976, pp. 309-322.

that these rates are unbiased predictors of the markets expectation of the spot rate on the date of the maturity of the forward contract.[44]

While the use of forecasting error as a proxy for exchange rate uncertainty is precisely what is considered appropriate, the approach taken in this study is that forward rates are not unbiased predictors for expected future rates. It was shown earlier that when the expected value of the future rate exactly equalled the forward rate for the corresponding maturity, net of marginal costs, complete hedging would be undertaken by exporters. In such a situation, exchange risk will not affect export decisions (see Chapter 2 and Appendix 1). Abstracting from costs, as Aliber does, the corresponding conclusion is that total hedging will occur when the forward rate exactly equals the predicted rate for the date of maturity of the forward contract.[45] Consequently, the use of forward rates as a proxy for expected rates

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[44] Hooper, P. & Kohlhagen, S.W., op.cit., found that this proxy yielded strong statistical results in their examination of the effects of exchange risk on the trade of several industrial countries.

[45] Farber, A.L., et.al., "A Note on the Optimal Level of Forward Exchange Transactions", unpublished manuscript, University of Brussels and CORE, September 1975.

is not considered appropriate, because such an assumption severely constrains the scope of the analysis. It may even be argued that the restriction is so severe that the results become trivial. No amount of exchange risk will affect export decisions, since all future earnings in foreign exchange are always sold through the forward market, at a known price.

The next section presents the approach taken in this study to develop a proxy for exchange rate uncertainty.

Exchange Rate Forecasting Methodology

The Box-Jenkins stochastic time series model is the statistical tool employed in this study to forecast exchange rates.[46] The choice of this method is predicated on the recognition of the weaknesses of the methods used hitherto, and on certain institutional considerations pertaining to the countries being examined in this study. Time series analysis examines the past

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[46] Box, G.E.P. and Jenkins, G.M., Time Series Analysis, (San Francisco, CA; Holden Day, 1970) is the basic text on this subject, and a useful presentation is also contained in Pindyck, R.S. and Rubinfeld, D.L., Econometric Models and Economic Forecasts, Chapters 13-17, (New York City, NY; McGraw Hill, 1976).

behavior of a time series in order to infer something about its future behavior. The model does not seek to establish any causal relationship between the variable being examined and its determinants.

While this approach may be criticized because it ignores widely accepted determinants of exchange rates, such as changes in reserve positions and in differential inflation and interest rates, it is considered an appropriate method for simulating the exporters' behavior in developing countries for several reasons.

First, data on such determining variables is seldom, if ever, available in a timely and reliable manner. The notorious lag in the availability of data would severely impair its usefulness in forecasting purposes, especially where essentially short-term forecasts are needed. Second, as stressed throughout, the financial markets in developing countries are rudimentary at best, and access to forward markets is highly regulated. Such regulation essentially breaks down the accepted linkages between these variables and exchange rates. For instance, differential interest rates cannot elicit the kinds of response from capital flows in developing countries as they can in industrial nations, simply because the citizens of such countries are prohibited by law from holding financial assets in foreign currency.

Consequently, they have little bearing on exchange rate movements. Also, due to the severity of government regulation, exporters in general do not consider forward rates as an element in their decision making.[47] Lastly, even if exporters did have access to the information in a timely manner, and financial institutions were fully developed, it is questionable whether they possess the sophisticated skills necessary for the design and use of complex models of exchange rate determination--or even whether the costs of such an effort would be considered justified, given their scale of operation.

Consequently, it is considered quite reasonable to assume that exporters in developing countries operate almost exclusively in a world of spot rates, and it follows directly from this argument that the time series model may be a more accurate representation of reality than one would allow initially.

To summarize the discussion so far, the proxy for exchange risk adopted in this study may be defined as some function of past forecasting errors:

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[47]Conversations with a leading exporter from Northern India revealed that in addition to the primitiveness of the forward market, government regulations inhibit Indian exporters from taking positions in the forward market. The regulations are so complex and cumbersome that it is typically not worthwhile to hedge exchange positions through the Government-run forward markets.

$$R = f(r^* - r) \qquad (4.2)$$

where,

R is the proxy for exchange risk.

r^* is the forecasted future spot rate in the past.

r is the observed spot rate in the period for which the rate was forecast as r^*.

Time series analysis is used to establish forecasted values, r^*.

The basic assumption underlying time series analysis is that the series being forecasted is generated by a random process which has a structure that can be identified and described. The description is in terms of the way that randomness is embodied in the process and does not attempt to establish any causal relationship between the forecasted series and other variables. In other words, given an exchange rate series $r_{t-n}, r_{t-n+1}, \ldots, r_t$ in period t, the assumption is that the series is a set of jointly distributed variables, and the aim of time series analysis is to specify the probability distribution function which assigns probabilities to all possible combinations of values of r_{t-n}, r_{t-n+1}, . . . , r_t. The probabilities of alternative future states could then be determined on the basis of this probability distribution function.

It is important to note that the attempt is to capture the characteristics of the series' randomness, and not necessarily to identify the actual distribution of the series which may be far more complicated and impossible to specify.[48] Thus, a simple model which is a reasonable approximation of the actual distribution is used for forecasting purposes. Clearly, the usefulness of the model depends on how accurately it represents the true probability distribution of the series.

Stationarity of Exchange Rate Series

The first step in time series analysis is the identification of a model which captures the randomness of the series. The stationary of the series is, in turn, an important first consideration in this identification process. A stationary series is one whose stochastic properties are invariant with respect to time, i.e., the probability of a given fluctuation from a mean level (which is itself constant over time) is the same at any point in time. If these stochastic properties change over time, the series is termed

[48]Pindyck, R.S. and Rubinfeld, D.L., op.cit., p. 431.

non-stationary. The task of describing a stochastic process is greatly simplified if the series is stationary.

Thus, it is expedient to determine if the series being examined (exchange rates in our case) is stationary, and if not, whether it can be readily transformed into one. A convenient indicator which can be used to determine if a series is stationary is the autocorrelation function which provides a measure of the degree of correlation between neighboring points in a series. The autocorrelation with lag k (ρ_k) for the exchange rate series $r_{t-n}, r_{t-n+1}, \ldots, r_t$, is defined as

$$\rho_k = \frac{E[(r_t-\mu_r)\ (r_{t+k}-\mu_r)]}{\sqrt{E[(r_t-\mu_r)^2]E[(r_{t+k}-\mu_r)^2]}} \tag{4.3}$$

where,

ρ_k is the autocorrelation with lag k.

μ_r is the mean of the series, and

E is the expectations operator.

For a stationary series, the variance at time t is the same as that at time t+k, and therefore, the denominator in 4.3 becomes the variance of the stochastic process. Thus,

$$\rho_k = \frac{\text{Cov}(r_t, r_{t+k})}{\sigma_r^2} \tag{4.4}$$

In practice, ρ_k is estimated by the sample autocorrelation function, defined as,

$$\hat{\rho}_k \quad \frac{\sum_{t=1}^{T-k} (r_t-\bar{r})(r_{t+k}-\bar{r})}{\sum_{t=1}^{T} (r_t-\bar{r})^2} \tag{4.5}$$

A characteristic of stationary series is that the autocorrelation functions drops off sharply as k, the number of lags, is increased. This can be used to decide if a particular series is stationary or not. The monthly exchange rate series[49] of India, Israel, Mexico, Korea and Taiwan for the period of pegged exchange rates and for the floating rate period were used to compute sample autocorrelation functions. The results are shown in Tables 4.1 to 4.5.[50] It is clear

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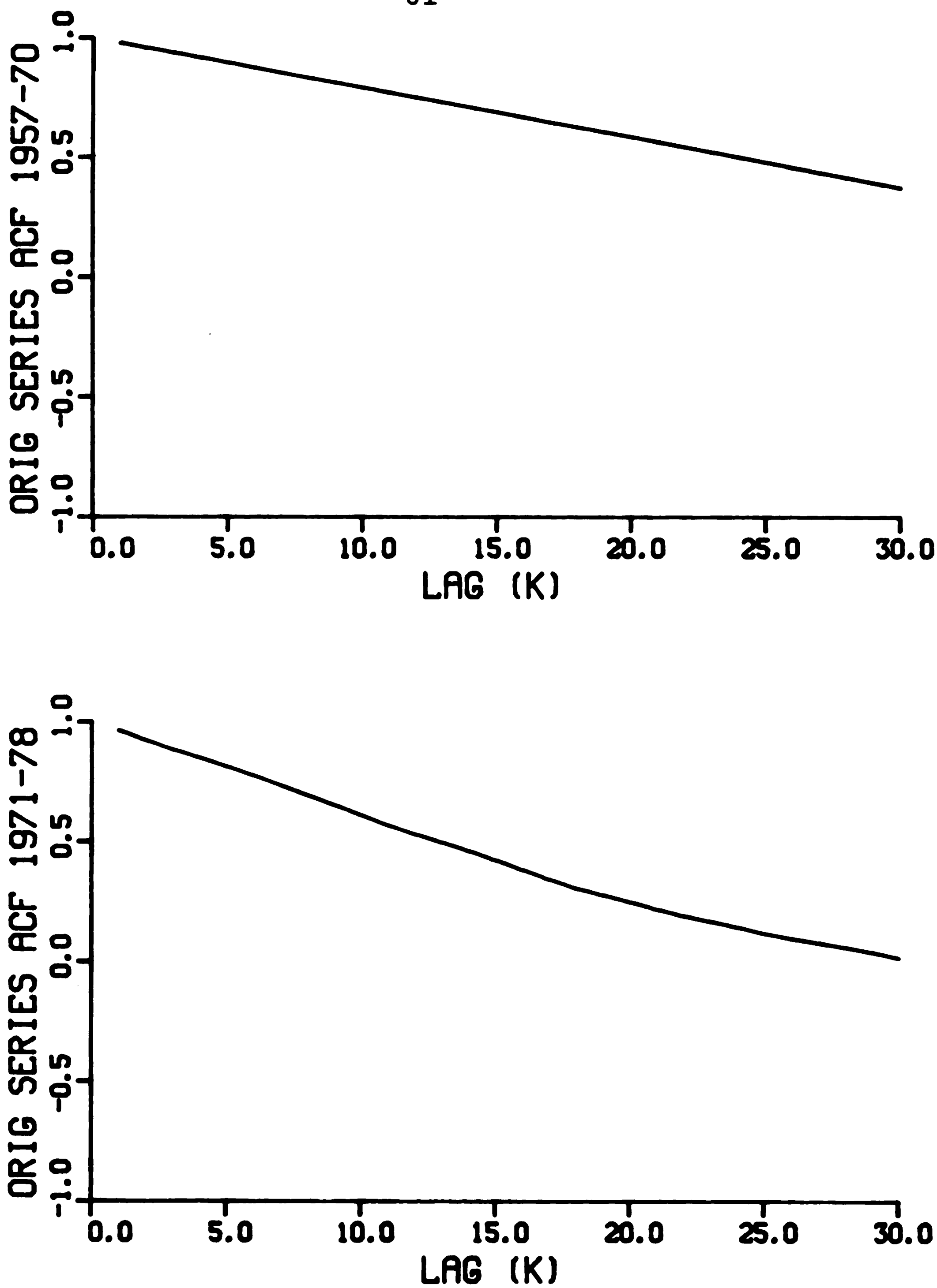
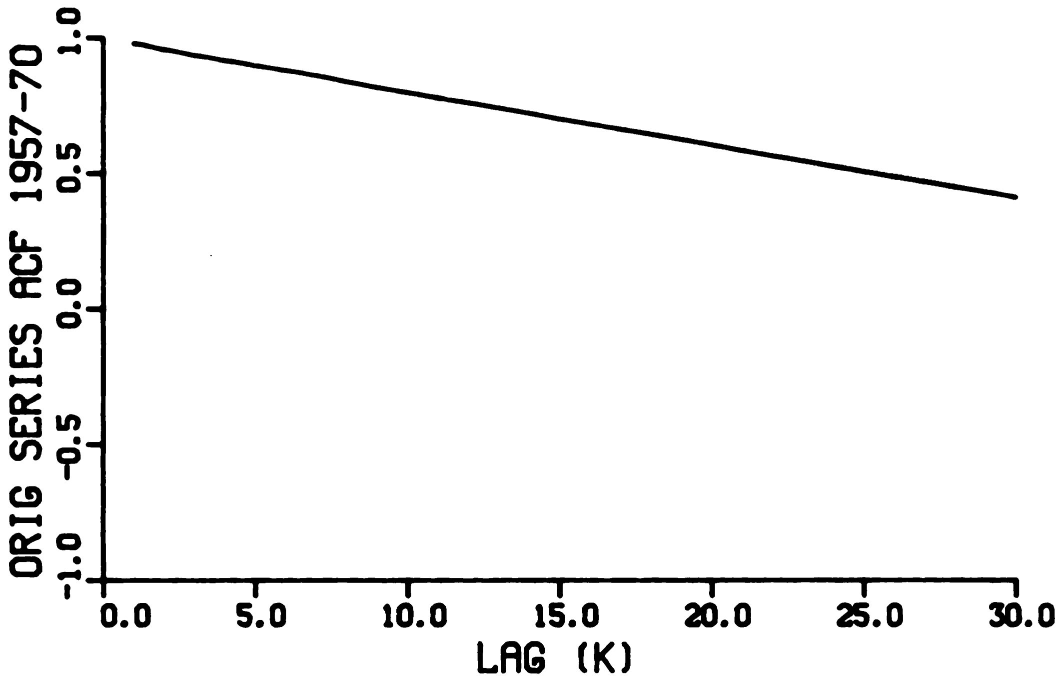
[49]SDR per unit of National Currency.

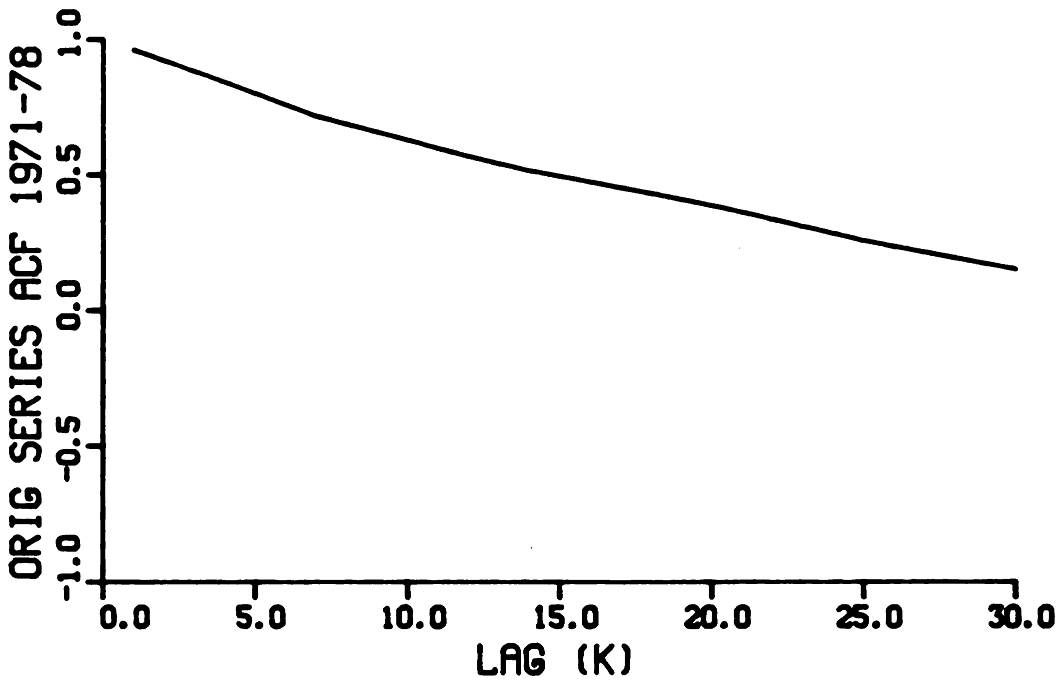
[50]There is an unresolved issue concerning the choice of a date of transition from pegged to floating rates. This question is addressed in detail later, but for the time being, it should be pointed out that for the purpose of identifying the structure of the exchange rate series, 1971 (Qtr. 1) was used as the cut-off date. This choice was made for two reasons. First, by March 1971, several countries had announced their intention of floating their currencies, and several others were clearly about to follow (see Farber, et.



Correlogram of Exchange Rate Series - INDIA

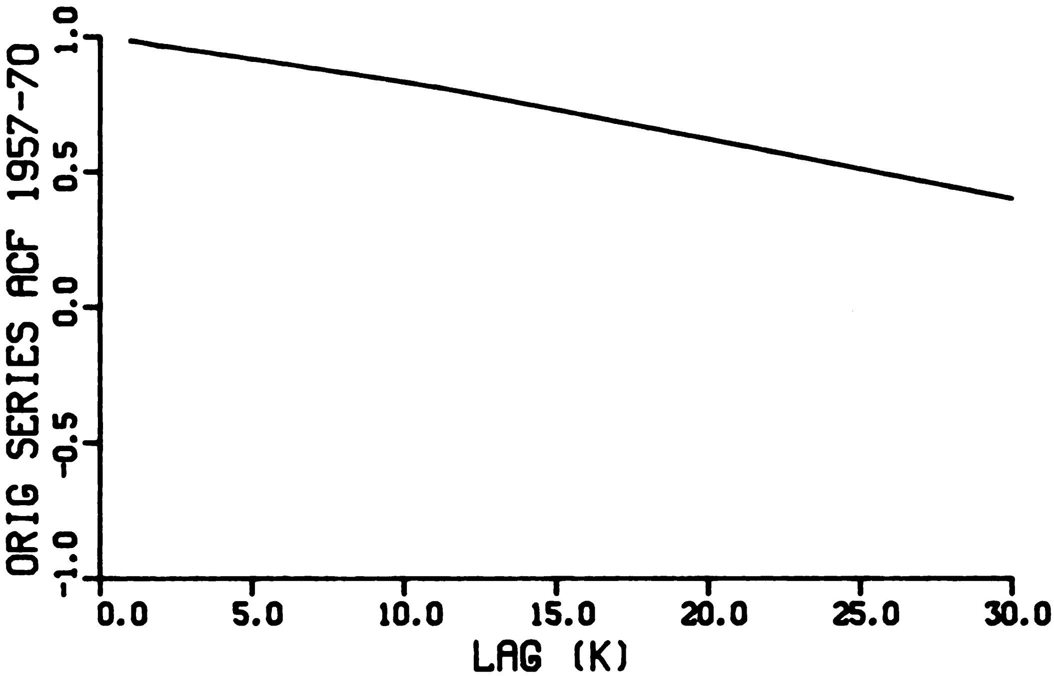
Figure 4.1

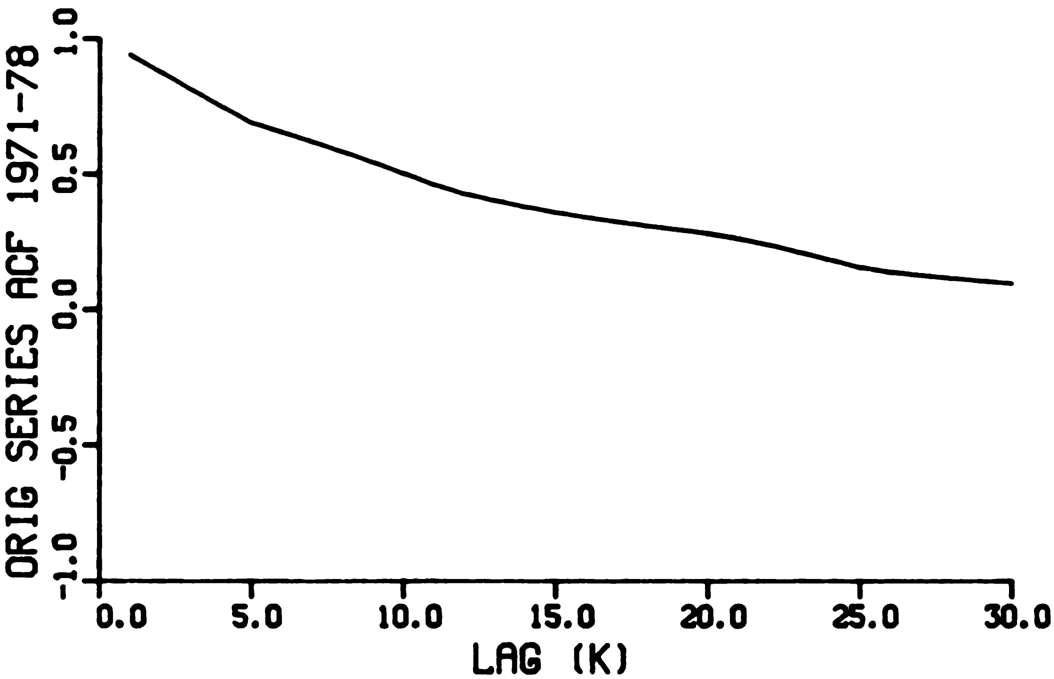




Correlogram of Exchange Rate Series - ISRAEL

Figure 4.2

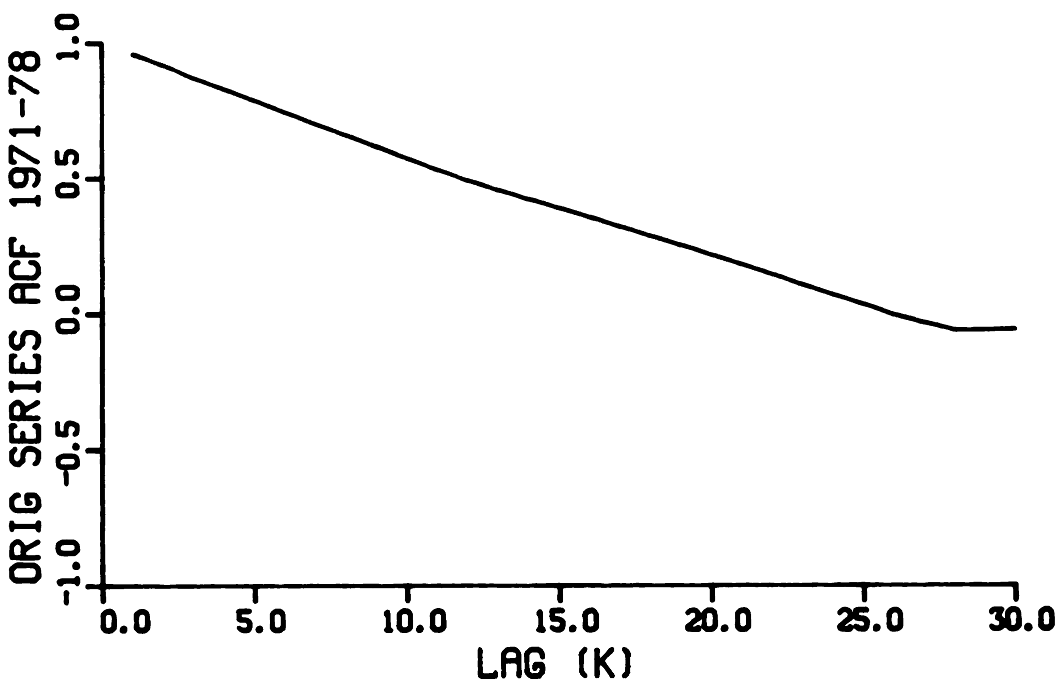




Correlogram of Exchange Rate Series - KOREA

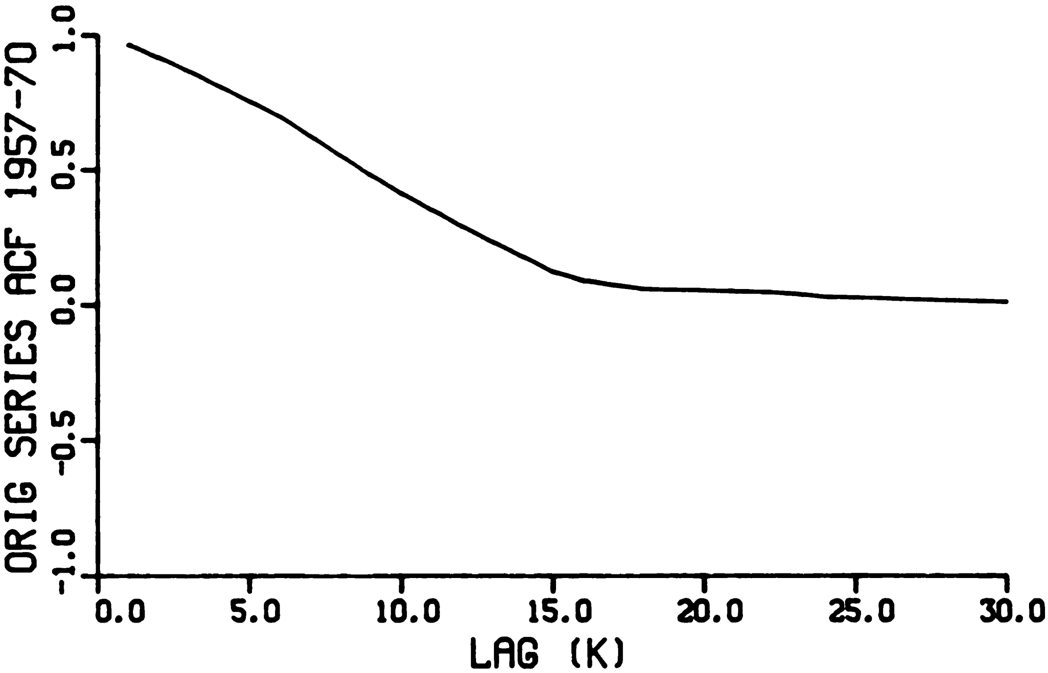
Figure 4.3

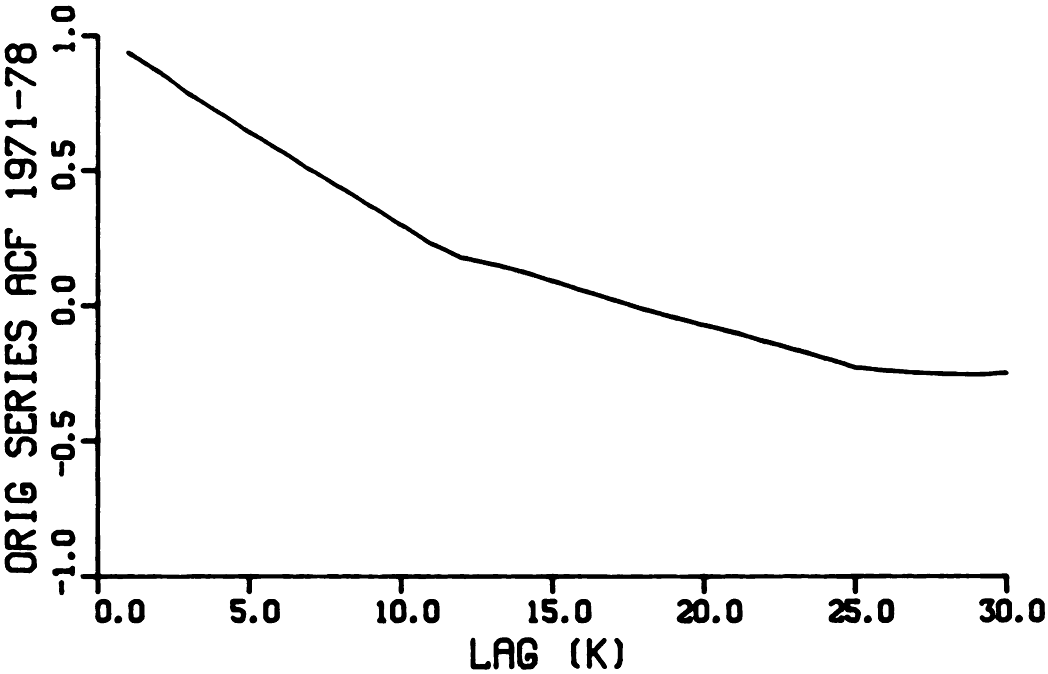
Mexico's exchange rate remained unchanged at 0.08 SDR per Peso throughout the period 1957-1970, and therefore a correlogram for this series could not be constructed.



Correlogram of Exchange Rate Series - MEXICO

Figure 4.4





Correlogram of Exchange Rate Series - TAIWAN

Figure 4.5

from these tables that, without exception, the series are non-stationary. The sample autocorrelation declines rather gradually as the lag increases from 1 to 30. To some extent, this is to be expected, since most time series in economics are non-stationary. However, many of the non-stationary series can be easily transformed into stationary series by the process of differencing. A non-stationary series which when differenced n times yields a stationary series is referred to as a homogeneous non-stationary series of order n.

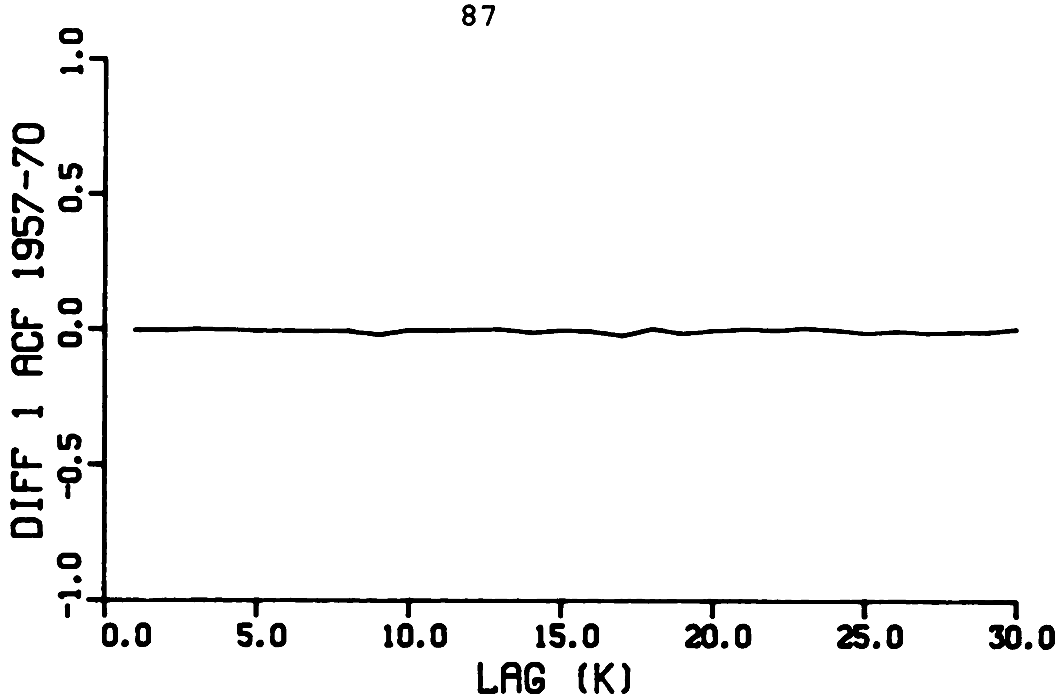
The ten exchange rate series being examined (two for each of the five countries) were differenced once, that is, the series

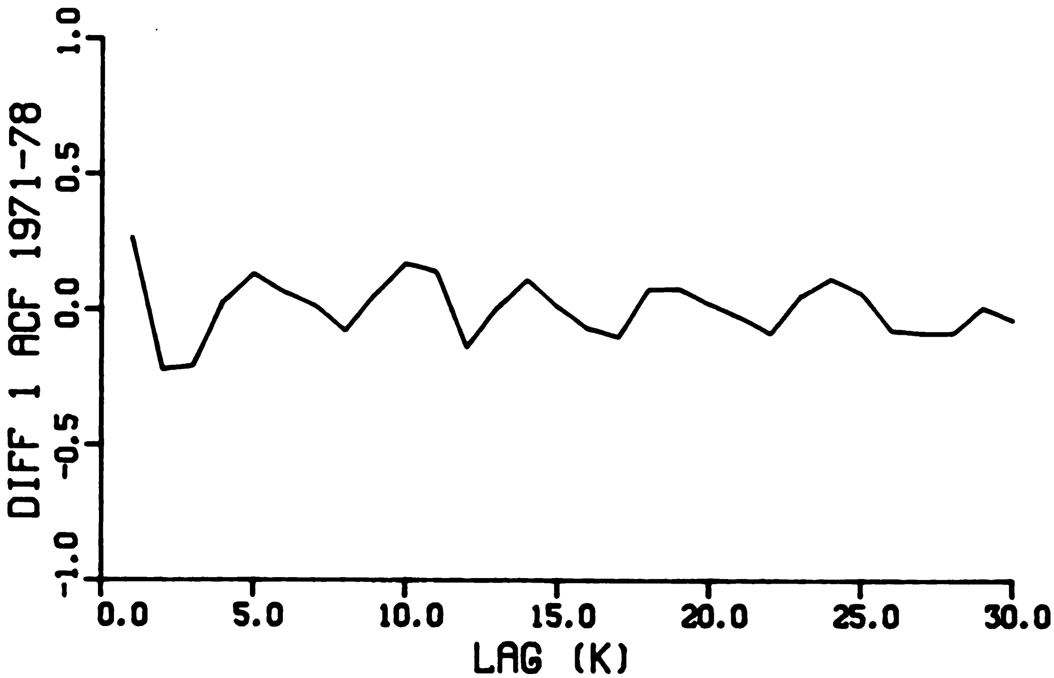
$$\overset{\Delta}{r}_t = r_t - r_{t-1} = \Delta r_t \qquad (4.6)$$

was constructed and the sample autocorrelation function for lags between 1 and 30 were computed. The resulting correlograms are presented in Figures 4.6 to 4.10. It was found that, without exception, each differenced exchange rate series, Δr_t, was stationary. The conclusion is that these exchange rate series are homogenous non-stationary of order 1.

50(contd.)

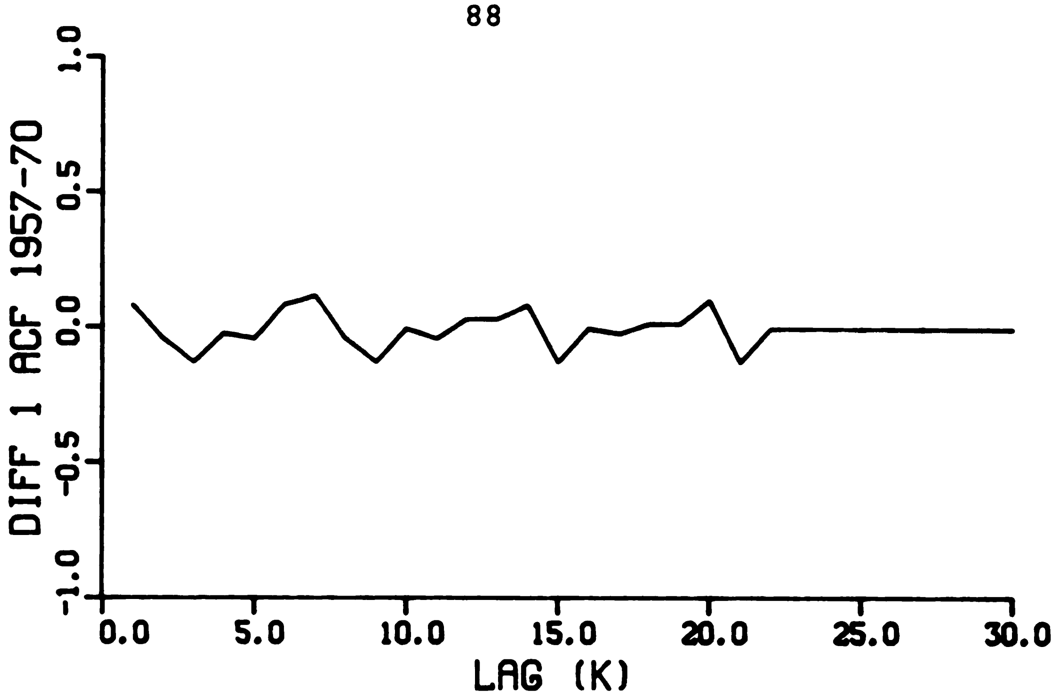
al., *op.cit.*, p. 240). Second, if any lag were to be discovered in the structure, observations from the post-1971 period would have to be used to obtain forecasts for the post-1973(I) period.

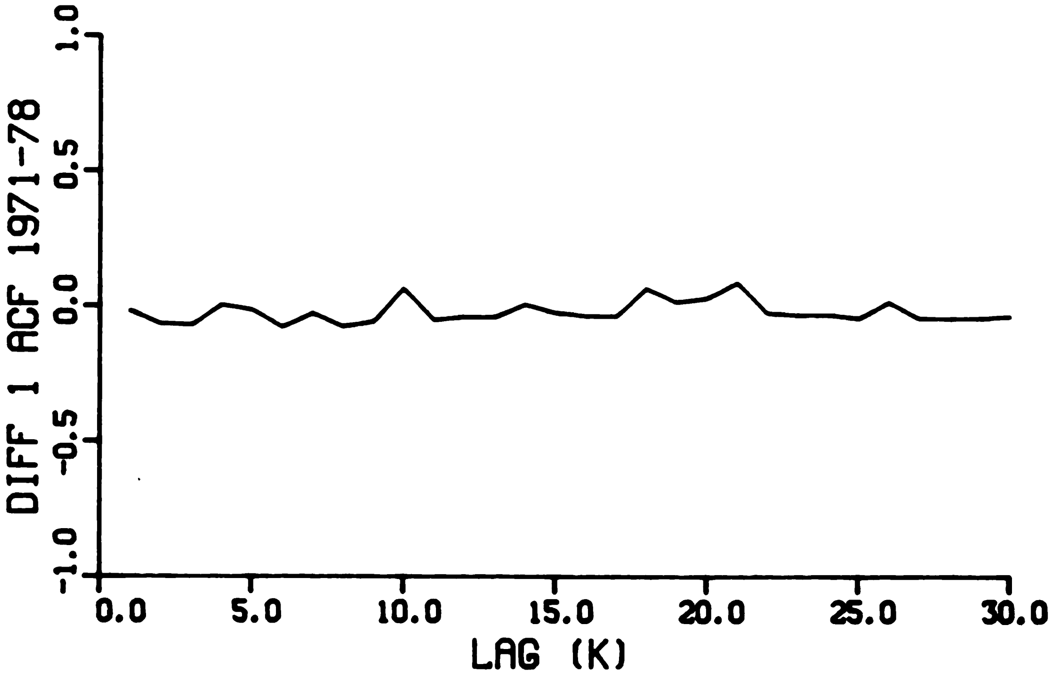




Correlogram of First Differenced
Exchange Rate Series - INDIA

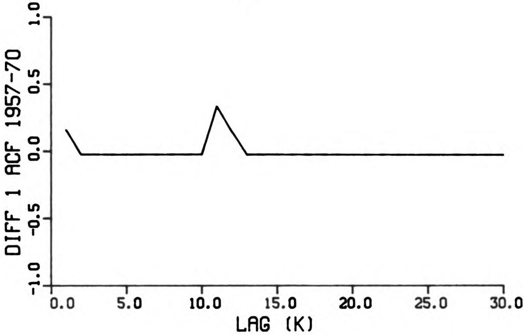
Figure 4.6

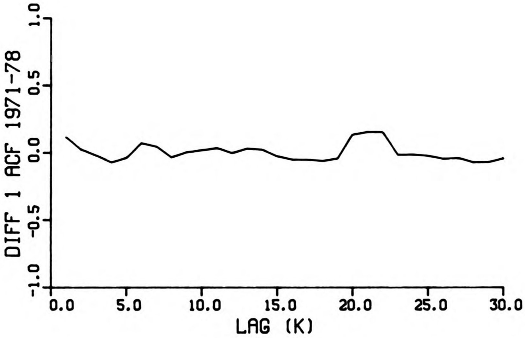




Correlogram of First Differenced
Exchange Rate Series - ISRAEL

Figure 4.7

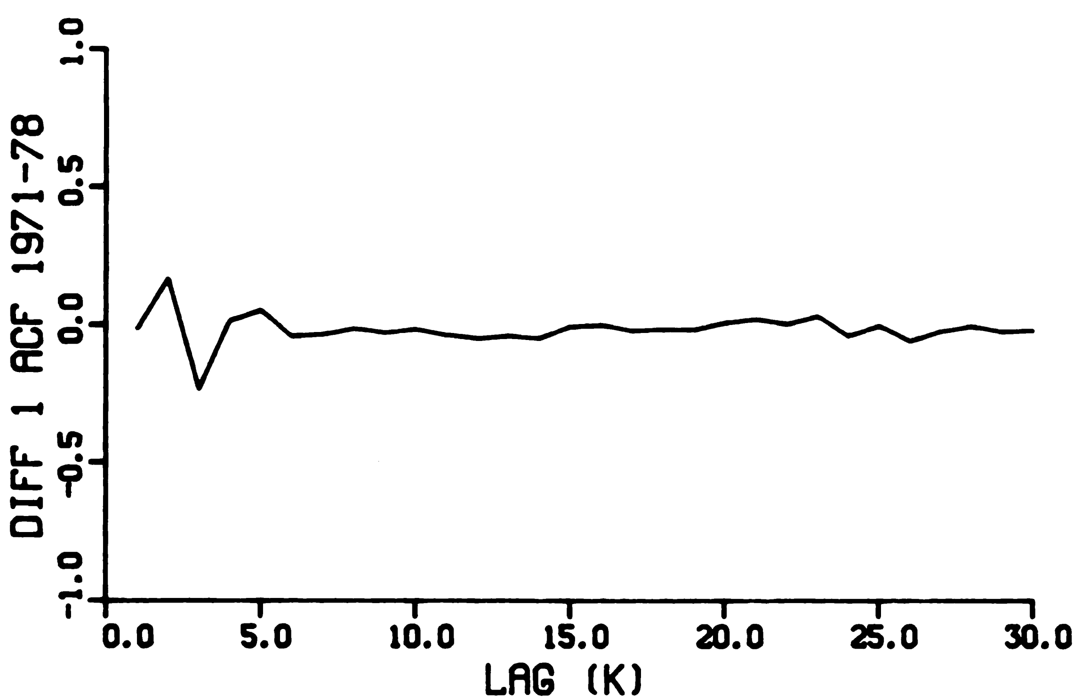




Correlogram of First Differenced
Exchange Rate Series - KOREA

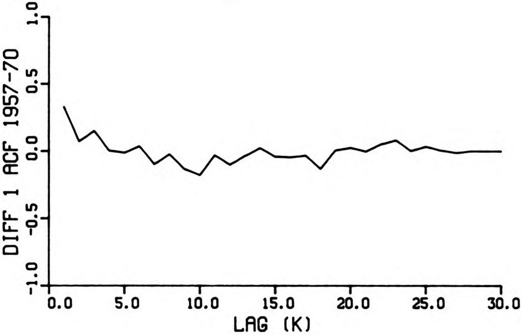
Figure 4.8

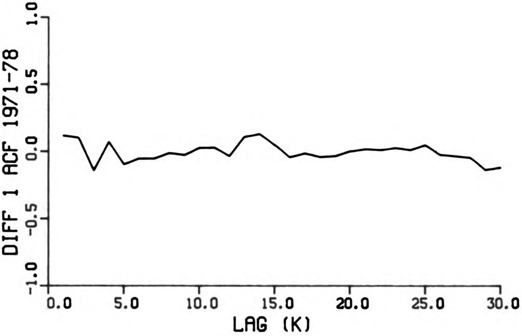
Mexico's exchange rate remained unchanged at 0.08 SDR per Peso throughout the period 1957-1970, and therefore a correlogram for this series could not be constructed.



Correlogram of First Differenced
Exchange Rate Series - MEXICO

Figure 4.9





Correlogram of First Differenced
Exchange Rate Series - TAIWAN

Figure 4.10

In addition, it was found that the differenced series, Δr_t were reduced to white noise. An examination of Table 4.1 will make this clear. The chi-square statistic computed from the sample autocorrelations and their corresponding standard errors was insignificant at the 95 percent level of confidence in all ten cases, and at the 90 percent level for all but one case. This was somewhat of a surprise, but the consistency of the finding among all nine series strengthened the conclusion that exchange rates for these countries during the two alternative exchange regimes were best characterized by a random walk process,

$$r_t = r_{t-1} + e_t \qquad (4.7)$$

with $E(e_t) = 0$ and $E(e_t, e_s) = 0$ for all $t \neq s$. In other words, each successive change in r_t is drawn independently from a probability distribution with 0 mean.[51]

Forecasting such a series is straightforward. Given the exchange rate series, $r_{t-n}, r_{t-n+1}, \ldots, r_t$, the forecast for one period ahead, r^*_{t+1}, is given by,

$$r^*_{t+1} = E[r_{t+1} | r_t, r_{t-1}, \ldots, r_{t-n}] \qquad (4.8)$$

But, $r_{t+1} = r_t + e_{t+1}$, and e_{t+1} is independent of

---

[51]Pindyck, R.S. and Rubinfeld, D.L., op.cit., pp. 432-440.

Table 4.1

Computed χ^2 Values for Autocorrelation Function

	χ^2 Statistic	
Country	1957-1970	1971-1978
India	38.159**	33.125**
Israel	19.916**	6.043**
Mexico	(1)	10.036**
Korea	29.007**	11.807**
Taiwan	40.277*	13.587**

* Not significantly different from 0 at 95% level of confidence.

** Not significantly different from 0 at 90% level of confidence.

(1) Mexico's exchange rate remained unchanged throughout this period, and hence, no value could be computed for it.

r_t, $r_{t-1}, \ldots, r_{t-n}$ (from 4.7). Thus, the forecast for one period ahead is simply,

$$r^*_{t+1} = r_t + E(e_{t+1}) = r_t \tag{4.9}$$

The forecast two periods ahead is,

$$\begin{aligned} r^*_{t+2} &= E[r_{t+2} | r_t, r_{t-1}, \ldots, r_{t-n}] \\ &= E[r_{t+1} + e_{t+2}] \\ &= E[r_t + e_{t+1} + e_{t+2}] \\ &= r_t \end{aligned}$$

Similarly, the forecast ℓ periods ahead will also be r_t.

Measuring Exchange Risk

The forecasting scheme resulting from the analysis of the previous section is used to develop measures of exchange risk under the pegged and floating rate systems. Two functional forms are used in this study, the root mean square error and the mean absolute error of the forecasts. The purpose of using both forms is to ensure the stability of the results. It is the inherent characteristic of most measures that they are either particularly sensitive to the frequency of the changes in the variable being examined or to the magnitude of the changes. Since exchange rates fluctuated more frequently but by relatively smaller amounts under the floating rates, the use of one measure with a particular sensitivity to either frequency or magnitude could easily introduce bias into the results. Therefore, two measures are used, one which is sensitive to frequency (mean absolute error) and another which is more sensitive to the magnitude of the changes (root mean square error). The stability of the resulting values of exchange risk under both measures would indicate their robustness.

Specifically, the two measures of exchange risk used are,

<u>Mean Absolute Error:</u>

$$R_t = \frac{1}{T} \sum_{i=1}^{T} \left| r^*_{t-i} - r_{t-i} \right| \tag{4.11}$$

and,

<u>Root Mean Square Error:</u>

$$R_t = \sqrt{\frac{1}{T} \sum_{i=1}^{T} (r^*_{t-i} - r_{t-i})^2} \tag{4.12}$$

where,

R_t is the measure of exchange risk in period t.

r_t^* is the exchange rate forecasted for period t in period t-1.

r_t is the observed exchange rate in period t.

Based on the discussion in the previous section, we know that the best forecast of future rates is r_t, and therefore, 4.11 and 4.12 may be written as,

$$R_t^1 = \frac{1}{12} \sum_{1}^{12} \left| r_{t-i-1} - r_{t-i} \right| \qquad (4.13)$$

and,

$$R_t^2 = \sqrt{\frac{1}{12} \sum_{i=1}^{12} (r_{t-i-1} - r_{t-i})^2} \qquad (4.14)$$

respectively, for T = 12.

The values of R_t^1 and R_t^2 under the pegged and floating rate systems are given in Tables 4.2 to 4.6 for the five countries under consideration. Table 4.7 shows the mean values of these measures under the two exchange regimes.[52]

[52] It should be noted that because these values are not invariant with respect to the unit of measurement, only intra country comparisons between the two periods are meaningful. The values for different countries under the same regime would be comparable only if they were normalized.

Table 4.2

Monthly Values of Exchange Uncertainty Proxy - INDIA

1960-1971(March) & 1973(April)-1978

$$R_t^1 = \frac{1}{12}\sum_{i=1}^{12}\left| r_{t-i-1} - r_{t-i}\right|$$

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1960	.0064	.0055	.0056	.0055	.0056	.0059	.0061	.0061	.0059	.0050	.0048	.0047
1961	.0050	.0045	.0057	.0057	.0059	.0056	.0056	.0058	.0073	.0085	.0081	.0078
1962	.0079	.0083	.0074	.0070	.0068	.0066	.0065	.0063	.0052	.0040	.0041	.0041
1963	.0033	.0029	.0025	.0030	.0030	.0026	.0023	.0019	.0016	.0017	.0016	.0013
1964	.0013	.0013	.0013	.0007	.0008	.0012	.0021	.0025	.0022	.0030	.0031	.0039
1965	.0041	.0043	.0045	.0048	.0052	.0056	.0050	.0045	.0048	.0055	.0057	.0049
1966	.0046	.0045	.0046	.0052	.0045	.0040	.2334	.2335	.2332	.2317	.2313	.2313
1967	.2313	.2318	.2319	.2325	.2323	.2325	.0039	.0038	.0038	.0038	.0038	.0094
1968	.0126	.0130	.0140	.0135	.0149	.0178	.0168	.0197	.0212	.0227	.0231	.0175
1969	.0181	.0187	.0196	.0192	.0191	.0191	.0219	.0194	.0207	.0197	.0226	.0226
1970	.0197	.0192	.0178	.0173	.0159	.0135	.0121	.0136	.0123	.0128	.0100	.0100
1971	.0100	.0151	.0147	-	-	-	-	-	-	-	-	-
1973	-	-	-	.1269	.1260	.1401	.1441	.1177	.1354	.1505	.1396	.1388
1974	.1610	.1927	.1828	.1934	.2083	.2024	.1972	.1886	.1742	.1609	.1594	.1475
1975	.1314	.1030	.0860	.0662	.0573	.0697	.0743	.0806	.0882	.0849	.0863	.0884
1976	.0814	.0781	.0767	.0788	.0763	.0564	.0503	.0528	.0434	.0546	.0613	.0613
1977	.0677	.0692	.0630	.0657	.0615	0619	.0554	.0518	.0619	.0548	.0490	.0588
1978	.0520	.0760	.0753	.0951	.1221	.1209	.1368	.1427	.1392	.1354	.1557	.1523

$$R_t^2 = \sqrt{\frac{1}{12}\sum_{i=1}^{12}(r_{t-i-1} - r_{t-i})^2}$$

1960	.0073	.0061	.0061	.0060	.0061	.0064	.0065	.0065	.0064	.0057	.0054	.0053
1961	.0056	.0054	.0072	.0072	.0073	.0070	.0070	.0072	.0092	.0101	.0100	.0098
1962	.0100	.0101	.0090	.0088	.0087	.0086	.0085	.0084	.0064	.0048	.0048	.0048
1963	.0039	.0036	.0033	.0039	.0040	.0037	.0036	.0033	.0028	.0029	.0028	.0027
1964	.0027	.0027	.0027	.0013	.0018	.0023	.0037	.0039	.0038	.0047	.0048	.0056
1965	.0056	.0057	.0057	.0058	.0063	.0068	.0062	.0060	.0061	.0074	.0075	.0070
1966	.0069	.0069	.0070	.0075	.0070	.0064	.7954	.7954	.7954	.7954	.7954	.7954
1967	.7954	.7954	.7954	.7954	.7954	.7954	.0066	.0066	.0066	.0066	.0066	.0205
1968	.0233	.0235	.0239	.0237	.0242	.0267	.0265	.0284	.0288	.0293	.0293	.0219
1969	.0230	.0234	.0242	.0241	.0240	.0240	.0259	.0239	.0253	.0248	.0273	.0273
1970	.0241	.0238	.0227	.0226	.0221	.0191	.0172	.0184	.0164	.0167	.0122	.0122
1971	.0122	.0242	.0241	-	-	-	-	-	-	-	-	-
1973	-	-	-	.1829	.1827	.1900	.1923	.1496	.1643	.1752	.1694	.1686
1974	.1884	.2240	.2108	.2212	.2286	.2250	.2220	.2194	.2093	.2007	.2005	.1958
1975	.1789	.1332	.1156	.0847	.0675	.0946	.1003	.1037	.1113	.1103	.1105	.1109
1976	.1073	.1053	.1051	.1061	.1042	.0748	.0650	.0687	.0539	.0687	.0751	.0751
1977	.0795	.0804	.0804	.0786	.0764	.0765	.0731	.0681	.0818	.0720	.0659	.0782
1978	.0735	.1232	.1232	.1438	.1738	.1737	.1823	.1859	.1833	.1824	.1993	.1971

Table 4.3

Monthly Values of Exchange Uncertainty Proxy - ISRAEL

1960-1971(March) & 1973(April)-1978

$$R_t^1 = \frac{1}{12}\sum_{i=1}^{12}\left| r_{t-i-1} - r_{t-i} \right|$$

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1960	0.0	0.0	0.0	0.0	0.0	0.0083	0.0166	0.0167	0.0167	0.0167	0.0167	0.0250
1961	0.0333	0.0333	0.0333	0.0333	0.0333	0.0333	0.0250	0.0333	0.0333	0.0333	0.0333	0.0333
1962	0.0250	0.0333	0.1333	0.1333	0.1333	0.1250	0.1250	0.1167	0.1167	0.1167	0.1167	0.1083
1963	0.1083	0.1000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1964	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1965	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1966	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1967	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0417
1968	0.0417	0.0417	0.0417	0.0417	0.0417	0.0417	0.0417	0.0417	0.0417	0.0417	0.0417	0.0
1969	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1970	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1971	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-
1973	-	-	-	0.0422	0.0422	0.0422	0.0422	0.0422	0.0422	0.0422	0.0422	0.0422
1974	0.0422	0.0422	0.0153	0.0	0.0	0.0	0.0	0.0003	0.0050	0.0081	0.1053	0.1939
1975	0.2001	0.2096	0.2157	0.2201	0.2262	0.2285	0.2412	0.2577	0.2537	0.3196	0.3177	0.1444
1976	0.1430	0.1474	0.1537	0.1554	0.1598	0.1696	0.1686	0.1648	0.1679	0.1130	0.1312	0.1381
1977	0.1440	0.1480	0.1441	0.1595	0.1596	0.1506	0.1524	0.1615	0.1906	0.1941	0.1962	0.6751
1978	0.6962	0.7404	0.7635	0.7983	0.8028	0.8168	0.8830	0.9337	0.9626	0.9642	1.0206	0.5328

$$R_t^2 = \sqrt{\frac{1}{12}\sum_{i=1}^{12}\left(r_{t-i-j} - r_{t-i}\right)^2}$$

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1960	0.0	0.0	0.0	0.0	0.0	0.0288	0.0408	0.0408	0.0408	0.0408	0.0408	0.0499
1961	0.0577	0.0577	0.0577	0.0577	0.0577	0.0577	0.0500	0.0577	0.0577	0.0577	0.0577	0.0577
1962	0.0499	0.0577	0.3512	0.3512	0.3512	0.3500	0.3500	0.3488	0.3488	0.3488	0.3488	0.3476
1963	0.3476	0.3476	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1964	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1965	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1966	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1967	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1443
1968	0.1443	0.1443	0.1443	0.1443	0.1443	0.1443	0.1443	0.1443	0.1443	0.1443	0.1443	0.0
1969	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1970	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1971	0.0	.0.0	0.0	-	-	-	-	-	-	-	-	-
1973	--	-	-	0.1072	0.1072	0.1072	0.1072	0.1072	0.1072	0.1072	0.1072	0.1072
1974	0.1072	0.1072	0.0529	0.0	0.0	0.0	0.0	0.0011	0.0162	0.0193	0.0211	0.6356
1975	0.6361	0.6369	0.6373	0.6374	0.6377	0.6378	0.6393	0.6420	0.6418	0.6846	0.6846	0.2573
1976	0.2569	0.2594	0.2620	0.2625	0.2641	0.2674	0.2668	0.2642	0.2645	0.1240	0.1401	0.1478
1977	0.1515	0.1565	0.1533	0.1692	0.1693	0.1643	0.1659	0.1772	0.2104	0.2135	0.2158	1.7302
1978	1.7333	1.7456	1.7487	1.7580	1.7584	1.7594	1.7802	1.7964	1.8055	1.8057	1.8240	0.6143

Table 4.4

Monthly Values of Exchange Uncertainty Proxy - MEXICO

1960-1971(March) & 1973(April)-1978

$$R_t^1 = \frac{1}{12}\sum_{i=1}^{12}\left|r_{t-i-1} - r_{t-i}\right|$$

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1960	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1961	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1962	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1963	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1964	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1965	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1966	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1967	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1968	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1969	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1970	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1971	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-
1973	-	-	-	0.126	0.126	0.126	0.126	0.126	0.126	0.126	0.126	0.126
1974	0.126	0.126	0.045	0.0	0.0	0.0	0.0	0.001	0.015	0.024	0.031	0.041
1975	0.054	0.073	0.085	0.094	0.106	0.111	0.111	0.145	0.157	0.159	0.153	0.144
1976	0.139	0.121	0.111	0.114	0.108	0.107	0.111	0.078	0.056	0.775	0.818	1.191
1977	1.581	1.645	1.803	1.806	1.800	1,811	1.822	1.842	1.858	1.143	1.110	0.753
1978	0.391	0.357	0.205	0.213	0.218	0.234	0.250	0.269	0.290	0.277	0.365	0.424

$$R_t^2 = \sqrt{\frac{1}{12}\sum_{i=1}^{12}(r_{t-i-1} - r_{t-i})^2}$$

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1960	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1961	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1962	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1963	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1964	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1965	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1966	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1967	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1968	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1969	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1970	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1971	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-
1973	-	-	-	0.319	0.319	0.319	0.319	0.319	0.319	0.319	0.319	0.319
1974	0.319	0.319	0.158	0.0	0.0	0.0	0.0	0.004	0.048	0.058	0.063	0.071
1975	0.084	0.106	0.115	0.119	0.126	0.127	0.127	0.175	0.190	0.191	0.190	0.187
1976	0.184	0.171	0.166	0.169	0.165	0.165	0.166	0.115	0.074	2.532	2.537	2.849
1977	3.165	3.172	3.220	3.221	3.221	3.221	3.221	3.222	3.223	1.995	1.990	1.511
1978	0.632	0.601	0.232	0.240	0.240	0.258	0.275	0.300	0.324	0.320	0.468	0.533

Table 4.5

Monthly Values of Exchange Uncertainty Proxy - KOREA

1960-1971(March) & 1973(April)-1978

$$\bar{R}^1_t = \frac{1}{12}\sum_{i=1}^{12}\left|r_{t-i-1} - r_{t-i}\right|$$

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1960	0.0	0.0	1.252	1.252	1.252	1.252	1.252	1.252	1.252	1.252	1.252	1.252
1961	1.252	4.167	5.418	5.418	5.148	5.148	5.148	5.148	5.148	5.148	5.148	5.148
1962	5.148	2.503	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1963	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1964	0.0	0.0	0.0	0.0	0.0	10.476	10.476	10.476	10.476	10.476	10.476	10.476
1965	10.476	10.476	10.476	11.093	11.710	2.505	2.505	2.505	2.566	2.566	2.566	2.566
1966	2.566	2.566	2.566	1.949	1.393	0.123	0.123	0.123	0.061	0.061	0.061	0.061
1967	0.061	0.243	0.243	0.304	0.242	0.242	0.303	0.363	0.363	0.363	0.363	0.666
1968	0.915	0.733	0.733	0.673	0.673	0.673	0.612	0.552	0.679	0.936	1.067	0.829
1969	0.580	0.580	0.647	0.713	0.780	0.848	0.848	0.984	0.926	0.807	0.887	1.932
1970	1.932	2.010	1.944	1.955	2.046	2.058	2.138	2.164	2.095	2.039	1.190	0.882
1971	0.965	1.055	1.225	-	-	-	-	-	-	-	-	-
1973	-	-	-	5.270	4.858	4.435	4.148	4.148	4.004	4.004	4.163	4.163
1974	4.163	4.322	1.767	0.318	0.318	0.318	0.318	0.351	0.795	1.084	1.158	1.461
1975	10.432	11.044	11.534	11.889	12.379	12.566	12.575	13.875	14.423	14.579	14.386	14.104
1976	5.456	4.708	4.304	4.434	4.189	4.139	4.306	3.030	2.170	1.935	1.941	1.951
1977	1.703	1.729	1.716	1.323	1.191	1.110	0.950	1.326	1.451	1.456	1.859	2.232
1978	2.903	3.369	3.475	3.850	3.850	4.431	4.936	5.287	5.884	5.799	7.438	8.666

$$R^2_t = \sqrt{\frac{1}{12}\sum_{i=1}^{12}(r_{t-i-1} - r_{t-i})^2}$$

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1960	0.0	0.0	4.336	4.336	4.336	4.336	4.336	4.336	4.336	4.336	4.336	4.336
1961	4.336	10.989	13.310	13.310	13.310	13.310	13.310	13.310	13.310	13.310	13.310	13.310
1962	13.310	8.672	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1963	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1964	0.0	0.0	0.0	0.0	0.0	36.291	36.291	36.291	36.291	36.291	36.291	36.291
1965	36.291	36.291	36.291	36.354	36.417	5.340	5.340	5.340	5.340	5.434	5.344	5.344
1966	5.344	5.344	5.344	4.898	4.412	0.301	0.301	0.301	0.213	0.213	0.213	0.213
1967	0.213	0.668	0.666	0.698	0.665	0.665	0.697	0.727	0.727	0.727	0.727	1.279
1968	1.542	1.407	1.407	1.391	1.391	1.391	1.376	1.360	1.429	1.684	1.744	1.409
1969	1.115	1.115	1.138	1.162	1.185	1.207	1.207	1.296	1.243	0.990	1.144	4.009
1970	4.009	4.018	4.011	4.014	4.044	4.046	4.056	4.067	4.061	4.042	3.986	1.075
1971	1.112	1.226	1.361	-	-	-	-	-	-	-	-	-
1973	-	-	-	10.437	10.339	10.234	10.186	10.186	10.174	10.174	10.189	10.189
1974	10.189	10.204	5.079	0.779	0.779	0.779	0.779	0.788	1.729	1.996	2.083	2.332
1975	31.164	31.273	31.319	31.343	31.389	31.396	31.396	31.733	31.882	31.903	31.894	31.876
1976	7.183	6.669	6.456	6.557	6.390	6.375	6.404	4.443	2.850	2.506	2.507	2.508
1977	2.261	2.266	2.261	1.547	1.351	1.280	1.126	1.863	2.015	2.021	2.547	2.905
1978	3.879	4.267	4.304	4.586	4.586	5.085	5.395	5.850	6.496	6.469	9.578	11.036

Table 4.6

Monthly Values of Exchange Uncertainty Proxy - TAIWAN

1960-1971(March) & 1973(April)-1978

$$R_t^1 = \frac{1}{12}\sum_{i=1}^{12}\left| r_{t-i-1} - r_{t-i} \right|$$

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec
1960	.2941	.0775	.0775	.1707	.1740	.1741	.1741	.1869	.1319	.1095	.1095	.1095
1961	.1095	.1095	.1095	.0162	.0129	.0129	.0129	0.0	0.0	0.0	0.0	0.0
1962	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1963	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	.0007	.0187	.0187
1964	.0187	.0187	.0187	.0187	.0187	.0187	.0187	.0187	.0187	.0181	0.0	0.0
1965	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1966	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1967	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1968	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1969	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1970	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1971	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-
1973	-	-	-	.1965	.1965	.1965	.1965	.1965	.1965	.1965	.1965	.1965
1974	.1965	.1965	.0319	0.0	0.0	0.0	0.0	.0031	.0455	.0731	.0953	.1242
1975	.1631	.2235	.2621	.2901	.3288	.3436	.3444	.4461	.4818	.4892	.4701	.4427
1976	.4292	.3706	.3390	.3489	.3297	.3256	.3385	.2380	.1705	.1519	.1523	.1536
1977	.1347	.1368	.1357	.1048	.0945	.0881	.0755	.1051	.1148	.1152	.1468	.1758
1978	.2281	.2647	.2730	.3025	.3025	.3482	.3879	.5006	.5442	.5370	6575	.7474

$$R_t^2 = \sqrt{\frac{1}{12}\sum_{i=1}^{12}(r_{t-i-1} - r_{t-i})^2}$$

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec
1960	0.7781	0.2058	0.2058	0.3830	0.3833	0.3833	0.3833	0.3833	0.3355	0.3264	0.3264	0.3264
1961	0.3264	0.3264	0.3264	0.0461	0.0446	0.0446	0.0446	0.0	0.0	0.0	0.0	0.0
1962	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1963	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0023	0.0627	0.0627
1964	0.0267	0.0627	0.0627	0.0627	0.0627	0.0627	0.0	0.0	0.0	0.0	0.0	0.0
1965	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1966	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1967	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1968	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1969	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1970	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1971	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-
1973	-	-	-	0.5808	0.5808	0.5808	0.5808	0.5808	0.5808	0.5808	0.5808	0.5808
1974	0.5808	0.5808	0.1106	0.0	0.0	0.0	0.0	0.0107	0.1475	0.1755	0.1917	0.2164
1975	0.2548	0.3299	0.3558	0.3688	0.3925	0.3928	0.3958	0.5371	0.5832	0.5879	0.5829	0.5742
1976	0.5651	0.5249	0.5081	0.5189	0.5027	0.5014	0.5036	0.3493	0.2238	0.1967	0.1968	0.1969
1977	0.1778	0.1782	0.1777	0.1221	0.1066	0.1010	0.0892	0.1468	0.1584	0.1589	0.2000	0.2283
1978	0.3048	0.3355	0.3384	0.3605	0.3605	0.3997	0.4240	0.6511	0.6840	0.6823	0.8612	0.9527

Table 4.7

Average Value of Exchange Risk - R^1 and R^2

Country	Mean Under Pegged Rates 1960-1971(March)	Mean Under Floating Rates 1973(April)-1978
	$R_t^1 = \frac{1}{12} \sum_{i=1}^{12} \left\| r_{t-i-1} - r_{t-i} \right\|$	
India	0.02	0.11
Israel	0.02	0.26
Korea	2.12	9.27
Mexico	0.00	0.42
Taiwan	0.02	0.24
	$R_t^2 = \sqrt{\frac{1}{12} \sum_{i=1}^{12} (r_{t-i-1} - r_{t-i})^2}$	
India	0.08	0.13
Israel	0.05	0.52
Korea	5.99	9.62
Mexico	0.00	0.78
Taiwan	0.05	0.37

It was pointed out earlier that the choice of an appropriate transition date from pegged to floating systems is a difficult one to make. This is so because the period between March 1971 and March 1973 is almost impossible to classify under either pegged or floating rate systems. By March 1971, many countries had announced their intention to float their currencies, and others were clearly going to follow suit. After several months of turmoil, exchange rates were pegged once again, following the Smithsonian Agreement of August 1971. When these arrangements collapsed in March 1973, the floating rate system became installed on a wide and permanent basis.[53]

Earlier research has indicated that choosing either March 1971 or March 1973 as the transition date can significantly affect the results of an analysis of exchange rate volatility under the alternative systems. Cline,[54] for instance, chose March 1973 as the transition date, and his finding was that exchange volatility had *not* significantly increased with the introduction of floating rates. But this choice implies that the

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[53] Yeager, L.B., International Monetary Relations: Theory, History & Policy, 2nd, ed., pp. 576-588 and 595-610 (New York, NY; Harper & Row, 1976).

[54] Cline, W.R., op.cit., p. 17.

period between March 1971 and August 1971 should be classified under pegged rates, which is not justifiable simply because several currencies were floating during this time. Other researchers used March 1971 as the date of transition[55] and came to an opposite conclusion.

Clearly, the choice of the transition date could have resulted in these contradictory findings. Therefore, the approach taken in this study is that neither date should be used as a transition point, but rather, the entire period March 1971 to March 1973 should be deleted from the analysis of exchange risk. This period should properly be viewed as a transition period which can be classified neither as pegged nor as floating. Accordingly, the average forecast errors presented in Table 4.7 consider the period 1960 (I) to 1971 (I) as representing the pegged system, and the period 1973 (II) to 1978 (IV) as representing the floating system.

It is fairly obvious from these figures that exchange risk increased substantially with the introduction of floating rates, on the average. On both measures, R_t^1 and R_t^2, exchange risk increased by a factor of more than five, with the exception of

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[55]Farber, A., Roll, R., and Solnik, B., op.cit., p. 236.

Korea in terms of R_t^1 and India and Korea in terms of R_t^2.

With the intention of further establishing the robustness of the chosen measures of exchange risk, two other measures were computed which have been used commonly

$$R_t^3 = \frac{1}{12}\sum_{i=1}^{12}\left|\frac{1}{12}\sum_{j=1}^{12} r_{t-i-j} - r_{t-i}\right| \qquad (4.15)$$

and,

$$R_t^4 = \sqrt{\frac{1}{12}\sum_{i=1}^{12}\left(\frac{1}{12}\sum_{j=1}^{12} r_{t-i-j} - r_{t-i}\right)^2} \qquad (4.16)$$

Measured in this way, also, exchange risk was found to have increased (by a factor of 8 or more, except in the case of Korea and India), as shown in Table 4.8. In no case does risk appear to have declined. The underlying assumption in 4.15 and 4.16 is that exporters forecast exchange rates on the basis of their average value over the past twelve months, i.e.,

$$r_t^* = \frac{1}{12}\sum_{j=1}^{12} r_{t-j} \qquad (4.17)$$

Table 4.8

Average Value of Exchange Risk - R^3 and R^4

Country	Mean Under Pegged Rates 1960-1971(March)	Mean Under Floating Rate 1973(April) 1978
$R_t^3 = \frac{1}{12} \sum_{i=1}^{12} \left| \frac{1}{12} \sum_{j=12}^{12} r_{t-i-j} - r_{t-i} \right|$		
India	0.14	0.27
Israel	0.09	1.31
Korea	12.72	21.66
Mexico	0.00	1.54
Taiwan	0.10	0.89
$R_t^4 = \sqrt{\frac{1}{12} \sum_{i=1}^{12} (\frac{1}{12} \sum_{j=1}^{12} r_{t-i-j} - r_{t-i})^2}$		
India	0.20	0.32
Israel	0.12	1.04
Korea	16.30	27.42
Mexico	0.00	1.91
Taiwan	0.12	1.50

CONCLUSIONS

It seems fairly reasonable to conclude from the results presented in Tables 4.7 and 4.8 that exchange risk had indeed increased under the floating rate system. Whether or not the increase significantly affected these countries' ability to exports, as the theory in Chapter 2 suggests, is quite another matter. The increased uncertainty may not have been of a large enough magnitude to measurably affect exports, given exporters ability to deal with it. Chapter 5 addresses this issue statistically, along the framework outlined in Chapter 3.

CHAPTER 5

ESTIMATION PROCEDURE AND RESULTS

Export supply is examined empirically in this chapter, to evaluate the influence of exchange risk on export level. For aggregate exports, the model of export supply specified in equation 3.1 is used for all five of the developing countries being examined--India, Israel, Korea, Mexico and Taiwan. Of these, only the latter three maintained pegged rates (to the U.S. dollar) throughout the observation period 1962-1978. India and Israel changed their pegging practices during this period, and thus the models of bilateral export supply discussed in Chapter 3 cannot be applied to them. For the others, the models of bilateral exports specified in equation 3.4 (single equation) and equations 3.4-3.6 (simultaneous system) are used to examine whether their exports showed a structural shift towards the U.S.A. after 1973. As discussed in Chapter 3, such a bias could be expected if exchange risk were important to the export decision, because it is asymmetrical for those currencies which are pegged to another.

Aggregate Exports

The functional form of the export supply equation represented by equation 3.1 is assumed to be log-linear, so that in estimable form it can be written as:

$$\log X^s_{t_i} = \beta_{0_i} + \beta_{0_i} \log XPI_{t_i} + \beta_{2_i} \log DPI_{t_i} + \beta_{3_i} \log CAP_{t_i} + \beta_{4_i} R^j_{t_i} + \sum_{n=1}^{4} \beta_{4+n_i} D_n + \varepsilon_{t_i} \quad (5.1)$$

where,

$X^s_{t_i}$ is the supply of exports in period t by country i.

XPI_{t_i} is the price index of country i's exports in period t.

DPI_{t_i} is i's domestic price index in period t.

$R^j_{t_i}$ are the measures of exchange risk in period t. R^1 and R^2 are used, both having been defined in the last chapter based on the time-series analysis of the exchange rates. For completeness, the results of estimating equation 5.1

with R_t^3 and R_t^4 (defined in equations 4.15 and 4.16) are presented in Appendix 4, Tables A4.1 and A4.2.

CAP_{t_i} is a measure of the productive capacity of country i in period t.

D_n are quarterly dummies, with n = 1,2,3.

D_4 is the dummy employed to account for the period 1971(II) to 1973(1) which it was determined could not be classified as either representative of the pegged or the managed floating rate systems.

ε_{t_i} is a stochastic disturbance term with the following usual[56] properties assumed:

(i) ε_{t_i} is normally distributed (Normality)

(ii) $E(\varepsilon_{t_i}) = 0$ (Zero Mean)

(iii) $E(\varepsilon_{t_i}^2) = \sigma^2$ (Homoskedasticity)

Non-antoregression is not assumed. It is tested for, using the Durbin-Watson test. Where the hypothesis of non-antoregression cannot be rejected, an assumption of first order serial correlation is made and the equations

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[56]Kmenta, J., Elements of Econometrics, p. 202 (New York, N.Y.; Macmillan, 1971).

are re-estimated using the Cochrane-Orcutt iterative technique.[57]

The specification of 5.1 is similar to that generally employed in estimations of export supply functions, except in two respects. Most previous efforts have assumed zero homogeneity of export supply with respect to export and domestic prices, and have estimated the elasticity of a single price variable in relative (ratio) form. In this study, it has been considered preferable to test for zero homogeneity instead of imposing the condition by assumption.[58]

The absence of money illusion is often thought of as equivalent to zero homogeneity. This is not correct. In fact, the absence of money illusion is neither a sufficient nor a necessary condition for zero homogeneity. The point is that the bundles of goods represented in the domestic price index and the export price index are likely to be different, particularly for developing countries. Even if they were the same, the weights of different commodities in the two indices may be different. In this case, if the domestic and export

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[57] See Madala, G.S., Econometrics, Chapters 8 and 12 (New York, N.Y.; McGraw Hill, 1977) for a discussion of this subject.

[58] This procedure was suggested in relation to the estimation of aggregate import demand functions in Tracy, M. and Ginman, P.J., "An Empirical Examination of the Traditional Aggregate Import Demand Model", RE Stat, February 1976, pp. 75-80.

prices of the same good increased by equivalent amounts, the ratio of the two indices would change. In reality, the relative competitive position of the good has not changed between the domestically sold and exported units.[59]

The second area of departure from traditional formulation is in the manner in which the capacity variable is defined. Most previous formulations have used income or industrial production as a proxy for capacity. The changes in industrial production from quarter to quarter can hardly be assumed to reflect changes in productive capacity. It is more likely that the quarterly fluctuations in part measure changes in utilization rates. Productive capacity will change more gradually. Therefore, following Goldstein & Khan,[60] the measure used for productive capacity, log CAP_t, is the logarithm of the trend of industrial production.

Equation 5.1 for each of the five countries was first estimated by ordinary least squares (OLSQ). Where the hypothesis of non-antoregression could not be rejected (because the computed Durbin-Watson Statistic fell in either the inconclusive or the rejection

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[59] Ibid., p. 70.

[60] Goldstein, M. and Khan, M.S., "The Supply & Demand for Exports: A Simultaneous Approach", RE Stat, March 1977, p. 285.

regions),[61] these equations were re-estimated using the Cochrane-Orcutt iterative method, as discussed earlier. An asymptotic 't-test' was then performed on the estimate of the autoregression parapeter, ρ. Where the null hypothesis of non-antoregression could not be rejected--this generally happened in those cases where the computed Durbin-Watson statistic had fallen in the inconclusive region--the OLSQ estimation results were presented.

In addition to the usual estimation results, the value of h (the sum of the estimated elasticities with respect to export and domestic prices) was also computed for each equation to test the zero homogeneity hypothesis. Both estimated coefficients $\hat{\beta}_1$ and $\hat{\beta}_2$, of which h is the sum, are asymptotically normally distributed, and thus h is too. Under zero homogeneity β_1 and β_2 would be equal but of opposite sign and therefore their sum, h, would be zero. The null hypothesis to be tested is

$$h = \beta_1 + \beta_2 = 0 \qquad (5.2)$$

[61]Madala, G.S., op.cit., p. 284.

The t-statistic to test the hypothesis that h=0 is formulated as

$$t_h = \frac{\hat{\beta}_1 + \hat{\beta}_2}{\sqrt{\text{Var } \hat{\beta}_1 + \text{Var } \hat{\beta}_2 + 2 \text{ Cov}(\hat{\beta}_1, \hat{\beta}_2)}} \qquad (5.3)$$

The estimation results using the two measures of uncertainty, R^1 and R^2, are presented in Tables 5.1 and 5.2.[62] The numbers in parentheses below the estimated coefficients are the corresponding t-statistics. Some of the coefficients have known expected signs and the interpretation of the price elasticity of export supply (β_{2_i}) is more complex than usual. Therefore, it is important to specify precisely the hypothesis to be tested for each of the estimated coefficients.

The elasticity of exports with respect to productive capacity is expected to be positive ($\beta_{3_i} > 0$); the cross elasticity of exports with respect to domestic prices and the coefficient of the uncertainty variable are expected to be negative ($\beta_{2i}, \beta_{4i} < 0$). For these three coefficients, a one-tailed t-test is appropriate. For the other five coefficients (excluding β_{1i}), the two-tailed test is employed.

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[62]Owing to data constraints, the observation periods for the five countries were not identical. They were: India 1962-77, Israel 1962-78, Korea 1963-78, Mexico 1962-77, Taiwan 1962-78. All data is from, "International Financial Statistics", IMF.

Table 5.1

Single Equation Estimation Results - R^1

(Aggregate Export Supply Function,
Adjusted for Serial Correlation Where Necessary)

$$R_t^1 = \frac{1}{12} \Sigma \left| r_{t-i-1} - r_{t-i} \right|$$

		P_x	P_d	CAP	R^1	D_1	D_2	D_3	D_4		
Country	β_0	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8	h^1	Rho
India	-0.247 (-0.24)	0.031* (1.92)	0.302 (1.27)	0.765* (1.76)	-0.654* (-2.41)	0.020 (0.63)	-0.120* (-3.61)	-0.078* (-2.58)	-0.013 (-0.21)	0.333 (1.39)	0.328* (2.75)
Israel	-1.124* (-4.95)	-0.030* (-3.10)	0.218 (3.84)	0.791* (8.80)	-0.173 (-1.58)	0.197* (6.18)	0.012 (0.36)	-0.185* (-5.79)	0.085* (1.98)	0.188* (3.44)	**
Korea	-2.775 (-1.72)	0.008 (0.23)	0.589 (1.89)	0.474* (2.68)	-0.002 (-0.32)	-0.234* (-10.69)	-0.022 (-0.86)	-0.054* (-2.44)	0.056 (0.82)	0.597* (1.97)	0.966* (29.77)
Mexico	4.191* (17.03)	-0.011 (-0.95)	-0.318* (-2.49)	0.393* (2.86)	0.062 (1.16)	-0.057 (-1.86)	-0.128* (-4.17)	-0.234* (-7.76)	-0.014 (-0.36)	-0.329* (-2.72)	**
Taiwan	-7.370 * (-17.39)	0.035* (1.98)	0.151 (0.97)	1.287* (16.68)	0.224 (1.53)	-0.112* (-2.73)	0.021 (0.51)	0.054 (1.32)	0.041 (1.32)	0.186 (1.27)	**

[1] $h = \beta_1 + \beta_2$

* Significantly different from 0 at 95 percent level of confidence. For β_{1i}, see equations 5.5 to 5.8.

**Estimated using OLSQ. Upon correction for serial correlation, it was found that ρ was not significant at 95 percent level of confidence.

Table 5.2

Single Equation Estimation Results - R^2

(Aggregate Export Supply Function,
Adjusted for Serial Correlation Where Necessary)

$$R_t^2 = \sqrt{\frac{1}{12} \Sigma (r_{t-i-1} - r_{t-1})^2}$$

Country	β_0	P_x β_1	P_d β_2	CAP β_3	R^2 β_4	D_1 β_5	D_2 β_6	D_3 β_7	D_4 β_8	h^1	Rho
India	-0.126 (-0.12)	0.027* (1.65)	0.228 (0.98)	0.084* (1.83)	-0.202* (-2.28)	0.019 (0.59)	-0.120* (-3.60)	-0.076* (-2.53)	-0.017 (-0.28)	0.255 (1.09)	0.349* (2.96)
Israel	-1.222* (-5.05)	-0.029* (-3.14)	0.222 (4.52)	0.787* (9.34)	-0.097* (-2.16)	0.120* (6.36)	0.013 (0.42)	-0.184* (-5.87)	0.088* (2.11)	0.193* (4.08)	**
Korea	-2.798 (-1.74)	0.010 (0.26)	0.597 (1.92)	0.472* (2.68)	-0.001 (-0.56)	-0.234* (-10.71)	-0.022 (-0.88)	-0.054* (-2.45)	0.055 (0.81)	0.607* (1.98)	0.966* (29.67)
Mexico	4.169* (16.89)	-0.013 (-1.05)	-0.287* (-2.29)	0.368* (2.71)	0.025 (0.89)	-0.054 (-1.78)	-0.125* (-4.08)	-0.232* (-7.76)	-0.011 (-0.28)	-0.300* (-2.53)	**
Taiwan	-7.364* (-18.79)	0.032* (1.85)	0.165 (1.10)	1.270* (16.71)	0.192 (2.30)	-0.114* (-2.83)	0.022 (0.55)	0.055 (1.38)	0.014 (0.21)	0.197 (1.40)	**

[1] $h = \beta_1 + \beta_2$

* Significantly different from 0 at 95 percent level of confidence. For β_{1i}, see equations 5.5 to 5.8.

**Estimated using OLSQ. Upon correction for serial correlation, it was found that ρ was not significant at 95 percent level of confidence.

The test for the own price elasticity of export supply is more complex. Jones and Berglas have proven that this elasticity (β_{1i}) can take on the negative values of greater than -1.[63] In other words, whereas supply elasticity is usually confined to positive values, the aggregate export supply price elasticity can also take on a value between 0 and -1. This holds true for aggregate exports even when the supply elasticity of each individual exported commodity is positive. This can be seen by noting that if balanced trade prevails, the relationship between the price elasticities of aggregate export supply and aggregate import demand is

$$\begin{array}{c}\text{Elasticity of}\\ \text{Export Supply}\end{array} = -\left(\begin{array}{c}\text{Elasticity of}\\ \text{Import Demand}\end{array}\right) - 1 \qquad (5.4)$$

It is clear from this relationship that if the elasticity of import demand is very low, the elasticity of export supply may become negative, reaching -1 as the former goes to 0.

The explanation for this, stated in simple terms, is that the income effect of an improvement in the terms of trade could swamp the usual production effect.

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[63] Jones, R.W. and Berglas, E., "Import Demand & Export Supply: An Aggregation Theorem", <u>AER</u>, March 1977, pp. 183-1987.

The relative price effect on imports is small where the elasticity of import demand is very low. Consequently, an increase in the price of exports could result in lower exports because although more exportables are produced, even more are now consumed domestically.

The testing procedure for the esimated price elasticity of export supply (β_{1i}) is complicated by the fact that β_{1i} can be both positive and negative (greater than -1). A single one- or two-tailed test is no longer adequate, because the acceptance region is disjoint. Instead, a two-step procedure as defined by the hypotheses 5.5-5.8 must be employed.

Step 1

Null hypothesis: H_o: $\beta_{1i} = 0$ (5.5)

Alternate hypothesis: H_A: $\beta_{1i} \neq 0$ (5.6)

If the null hypothesis 5.5 is rejected *and* $\hat{\beta}_{1i} < 0$,

Step 2

Null hypothesis: $\beta_{1i} = -1$ (5.7)

Alternate hypothesis: $\beta_{1i} > -1$ (5.8)

which is a one-tailed test. Clearly Step 2 is redundant if $\hat{\beta}_{1i} > 0$.

The t-statistic for Step 2 is constructed as follows:

$$t_{\beta_{1i}} = \frac{\hat{\beta}_{1i}-(-1)}{\text{standard error of } \hat{\beta}_{1i}} \tag{5.9}$$

We can now state the entire set of tests for all the estimated elasticities and coefficients as follows:

Null hypotheses: Ho_1: $\beta_{ji} = 0$ (5.10)

Ho_2: $\beta_{1i} = -1$ (5.11)

where j = 0,1,...,8 and i = 1,2,...,5.

Alternate hypotheses: HA_1: $\beta_{3i} > 0$ (5.12)

HA_2: $\beta_{1i} > -1$ (5.13)

HA_3: $\beta_{ji} \neq 0$, j = 0,1,5,...,8 (5.14)

HA_4: $\beta_{ji} < 0$, j = 2,4 (5.15)

where i = 1,2,...,5 in all cases. Clearly Ho_2 and HA_2 are employed *if and only if* hypothesis 5.10 is rejected for β_{1i} *and* $\hat{\beta}_{1i} < 0$.

At the 5 percent level of significance, the rejection region for the one-tailed test is defined by a t-statistic of 1.645 of appropriate sign. For the two-tailed tests, it is defined by a t-statistic of 1.96.

It is clear from the estimation results that the assumption of zero homogeneity in prices can be rejected for three of the five countries (Israel, Korea, Mexico) at the 5 percent level of significance, indicating that price elasticities should be estimated separately, without the usual constraint which implicitly assumes zero homogeneity.

Another interesting feature is the relatively small price elasticities coupled with large and highly significant coefficients on the productive capacity variable for every country. This is consistent with the export-oriented development strategy of these countries. The pressure to export is particularly significant, and consequently, export price does not play as important a role in the export decision as does capacity. Interestingly, productive capacity is significant even for countries such as Mexico and India which are generally viewed as import substituting countries. The evidence indicates that even these countries are export-oriented.

Another important reason for the significance of productive capacity in export decisions relates to a particular feature of some export incentive schemes. In India, for instance, exporters are granted import licenses in direct proportion to their export volume. Because of generally stringent import limitations, these import licenses command extremely high premiums. Indeed, profits of several hundred percent over the licensed import value are not uncommon, just from the sale of the licenses themselves. It is understandable, then, that export prices have less impact on the export decisions.

The uncertainty variable is significantly negative only in the case of India when R^1 is used. With R^2, it becomes significant for Israel also. The conclusion is that exchange rate uncertainty does not adversely affect aggregate exports in each country. While this may seem surprising at first, examination of the effect of export incentive schemes (such as the one cited for India) explains this unexpected result.

Typically, in trade analyses, a separation between exporters and importers is assumed. However, many export incentive schemes cause exporters to become de facto importers. Thus, any exchange risk perceived in the export market is offset by exchange risk in the opposite direction as the exporter participates in the import (or import license) market. In this situation, obviously, exchange rate uncertainty will not deter exports to the extent that it would for pure exporters.

Another explanation for the small influence of exchange uncertainty on export decisions relates to the currency denomination of export contracts. Clearly, if all export contracts are denominated in domestic currency, the entire burden of exchange risk is borne by the importer. The converse is true if all exports are denominated in the importer's domestic currency. When they are denominated in a third currency, the risk is shared. It is extremely difficult, if not impossible, to determine the currency denomination of exports of a country. Data on this simply does not exist in published form. Some efforts have been made to estimate the proportion of exports denominated in domestic currency for exports of the U.S.A. and Sweden.[64] Such an estimation was not undertaken for the countries being examined in this study because the question raised here is different. The important distinction is not

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[64] Grassman, Sven, "Currency Distribution and Forward Cover in Foreign Trade: Sweden Revisited, 1973", Journal of International Economics, May 1973, pp. 215-222, and Magee, S.I., "U.S. Import Prices in the Currency-Contract Period", Brookings Papers on Economic Activity, I/74, pp. 117-164.

between the proportion of export contracts denominated in domestic versus foreign currency, because hardly any exports are denominated in domestic currency in the countries being examined. The question, instead, is whether exports are denominated in a center currency (such as the U.S. dollar for Mexico) or in the currency of the importing country. This would be very difficult, if not impossible, to determine.

We now turn to the influence of exchange risk on the bilateral trade of the three countries which maintained pegged rates with a major currency. These countries are Mexico, Korea and Taiwan, all three having been pegged to the U.S. dollar throughout the observation period.[65]

Bilateral Exports

The objective of examining the bilateral export supply function, as discussed earlier, is to test if the exports of those developing countries that consistently pegged their currencies to one major currency underwent a structural shift towards the center currency, when floating rates were introduced in 1973. Korea, Mexico

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[65] Observation periods are the same as for aggregate exports. Bilateral trade flow data are from "Direction of Trade", IMF. All other data are from "International Financial Statistics", IMF.

and Taiwan fall into this category (of the five countries considered in this study)--and the U.S. dollar was the center currency in all three cases. The four (or five, depending on data availability) largest importers of their exports were identified for the purpose of this investigation, based on exports in the first quarter of 1973. As could have been expected, the U.S.A., being the center country, was among the top four importing countries (although no necessarily the largest), in each case.

Each developing country's bilateral export supply function to its largest importing nations is estimated first as a single equation and then as a simultaneous equation system. This was deemed important, because a comparison of the results would indicate whether the small country assumption is justified for bilateral trade (see the discussion in Chapter 3 on this point).

Single Equation Model

The single equation model of bilateral export supply specified in equation 3.4 can be written in estimable form as

$$\log X_{ij}^{s} = \alpha_{ij}^{0} + \alpha_{ij}^{1}\log P_{x_i} + \alpha_{ij}^{2}\log P_{d_i} + \alpha_{ij}^{3}\log CAP_i + \alpha_{ij}^{4}\, U + \sum_{n=1}^{4} \alpha_{ij}^{4+n}\, D_n + \varepsilon_{ij}^{1} \,. \qquad (5.16)$$

The subscript i represents the exporting country, and the subscript j represents the importing country. The time subscript, t, is omitted for notational convenience. U is a dummy variable used to capture structural shifts in the supply function, and is the focus of attention in this investigation. It takes on a value of 0 for the period prior to 1973 (II) and a value of unity thereafter. All other variables are the same as defined in the context of equation 5.1 except that X_{ij}^{s} now represents bilateral exports from country i to country j.

The hypotheses tested are also the same as for the aggregate export supply equation, with the exception of α_{ij}^{4} (the coefficient of the uncertainty dummy, U) which replaces β_4.

As explained earlier, α_{ij}^{4} can be either positive or negative for the center country, but in either case, we would expect that the coefficient is larger for the center country than it is for the other countries. Assigning j=1 for the U.S.A., we can say that

$$\alpha_{i1} - \alpha_{ij} > 0, \; j = 2,3,\ldots \text{ and} \tag{5.17}$$

$$i = \begin{cases} 1 \text{ for Korea} \\ 2 \text{ for Mexico} \\ 3 \text{ for Taiwan} \end{cases}$$

if it is true that exports are biased towards the center country.

The t-test used to test the hypothesis 5.17 is

$$t = \frac{\hat{\alpha}_{i1} - \hat{\alpha}_{ij}}{\sqrt{\text{Var } \hat{\alpha}_{i1} + \text{Var } \hat{\alpha}_{ij} - 2 \text{ Cov}(\hat{\alpha}_{i1}, \hat{\alpha}_{ij})}} \tag{5.18}$$

$$j = 2,3,\ldots$$
$$i = 1,2,3.$$

Of course, if $\hat{\alpha}_{ij}$ and $\hat{\alpha}_{i1}$ are both insignificantly different from zero, the t-statistic defined in 5.18 will also be insignificant.

The results of estimating 5.17 are presented in Tables 5.3-5.5 for Korea, Mexico and Taiwan respectively. Again, the numbers in parentheses below the estimated values of the coefficients are the corresponding t-statistics. As before, the equations were estimated using the Cochrane-Orcutt iterative method for adjusting for serial correlation. If the ρ was found to be insignificant based on an asymptotic t-test, the equations were re-estimated using ordinary least squares.

Table 5.3

Single Equation Estimation Results: Bilateral Exports - KOREA

Importing Country	α^0	P_x α^1	P_d α^2	CAP α^3	U α^4	D_1 α^5	D_2 α^6	D_3 α^7	D_4 α^8	Rho
U.S.A.	6.091* (2.97)	-0.002 (-0.05)	0.050 (0.13)	0.390* (1.74)	-0.140 (-0.79)	-0.143* (-5.20)	0.164* (5.06)	0.112* (4.06)	0.126 (1.02)	0.97* (30.21)
Japan	0.924 (0.74)	-0.028 (-0.41)	0.423 (0.93)	0.950* (3.19)	0.132 (0.49)	-0.261* (-6.01)	-0.134* (-2.71)	-0.094* (-2.21)	-0.030 (-0.163)	0.07* (13.16)
Canada	0.138 (0.08)	-0.246* (-2.35)	-0.943 (-1.16)	1.906* (3.53)	0.592* (1.22)	-0.194 (-1.88)	0.047 (0.41)	-0.140 (-1.39)	0.546 (1.66)	0.10* (5.86)
Germany	-2.044 (-1.67)	-0.220* (-3.33)	0.097 (0.17)	1.397* (3.66)	0.722* (2.11)	-0.001 (-0.01)	0.183 (1.57)	0.049 (0.47)	0.436 (1.92)	0.12* (2.69)
United Kingdom	-2.350* (-2.14)	0.104* (1.76)	0.430 (0.82)	1.078* (3.10)	0.525 (1.69)	0.001 (0.01)	0.060 (0.70)	-0.106 (-1.44)	0.070 (0.33)	0.11* (4.56)

* Significant at the 95% level of confidence. For α^1 see equations 5.5 to 5.8

Table 5.4

Single Equation Estimation Results:
Bilateral Exports - MEXICO

Importing Country	α^0	P_x α^1	P_d α^2	CAP α^3	U α^4	D_1 α^5	D_2 α^6	D_3 α^7	D_4 α^8	Rho
U.S.A.	3.598* (4.32)	-0.005 (-0.24)	-0.313* (-2.06)	0.383* (1.77)	0.099 (0.75)	-0.028 (-0.71)	-0.022 (-0.54)	-0.203* (-5.58)	0.055 (0.63)	0.132* (1.84)
Japan	7.245* (2.59)	-0.039 (-0.54)	-1.190* (-2.31)	-0.156 (-0.21)	0.328 (0.77)	-0.293 (-1.60)	-0.555* (-3.04)	-0.198 (-1.10)	-0.283 (-0.87)	**
Canada	-0.115 (-0.05)	0.049 (0.83)	-1.110* (-2.63)	0.982 (1.59)	0.991 (2.86)	0.015 (0.09)	0.183 (1.23)	0.056 (0.38)	0.401 (1.51)	**
Germany	3.898* (2.34)	-0.070* (-1.65)	-0.859* (-2.80)	0.016 (0.03)	1.015 (4.04)	-0.071 (-0.65)	-0.026 (-0.24)	-0.219* (-2.05)	0.004 (0.02)	**

* Significantly different from zero at 95% level of confidence. For α^1 see equations 5.5 to 5.8.

** Estimated using OLSQ. Upon correcting for serial correlation, it was found that ρ was not significant at 95% level of confidence.

Table 5.5

Single Equation Estimation Results:
Bilateral Exports - TAIWAN

Importing Country	α^0	P_x α^1	P_d α^2	CAP α^3	U α^4	D_1 α^5	D_2 α^6	D_3 α^7	D_4 α^8	Rho
U.S.A.	-0.414 (-0.31)	-0.011 (-0.31)	-0.551 (-1.50)	1.726* (12.42)	0.174 (0.86)	-0.124* (-2.65)	0.010 (0.19)	0.067 (1.47)	0.092 (0.74)	0.110* (3.32)
Japan	-0.439 (-0.20)	0.080* (1.80)	0.115 (0.19)	0.819* (4.27)	0.452 (1.44)	-0.151 (-1.46)	0.259* (2.49)	0.135 (1.30)	0.200 (1.17)	**
Canada	-1.677 (-0.74)	-0.117* (-2.07)	-0.648 (1.02)	1.549* (6.55)	0.196 (0.56)	0.014 (0.17)	0.144 (1.59)	0.237* (2.92)	0.262 (1.68)	0.115* (3.04)
Germany	-1.753 (-1.15)	-0.101* (-3.23)	0.084 (0.19)	0.936* (6.91)	0.389 (1.75)	-0.011 (-0.16)	-0.133 (-1.81)	0.045 (0.61)	0.107 (0.87)	**

* Significantly different from zero at 95% level of confidence. For α^1 see equations 5.5 to 5.8.

** Estimated using OLSQ. Upon correcting for serial correlation, it was found that ρ was not significant at 95% level of confidence.

All the estimated elasticities had expected signs, although many were not significant. The productive capacity variable once again performed strongly being significant in all cases for Korea and Taiwan and for Mexico's exports to the U.S.A.

The uncertainty dummy performed in a consistent but unexpected manner--exports were, if anything shifting away from the U.S.A. Each of the t-statistics (defined in equation 5.18) was found to be negative, indicating a shift of exports away from the U.S.A. In the case of exports to Germany by Korea and Mexico, this structural shift was statistically significant (see Table 5.6). The unambiguous conclusion from these results is that the exports of these developing countries did not shift in favor of the center country as a result of asymmetric exchange risk.

It should be noted at this point that these results are based on single equation estimation. Thus, it could very well be that differential growth and inflation rates among the importing countries since 1973 swamped the effect of exchange risk and accounted for the apparent shift in exports away from the center country. This would be clarified if estimation was conducted using a simultaneous approach--because the export demand function would include domestic inflation and

Table 5.6

Test of Hypothesis - Values of t-statistic

Null hypothesis: $\alpha_{i1} - \alpha_{ij} = 0, \; j \neq 1$

Alternate hypothesis: $\alpha_{i1} - \alpha_{ij} > 0, \; j \neq 1$

Exporting Country \ Importing Country	Center Country: U.S.A. (j=1)			
	Japan	Canada	Germany	U.K.
Korea	-0.845	-1.421	-2.235*	-1.852
Mexico	-0.603	-1.639	-3.753*	-
Taiwan	-0.366	-0.054	-0.861	-

$$t_{ij} = \frac{\alpha_{i1} - \alpha_{ij}}{\sqrt{\text{Var}\,\alpha_{i1} + \text{Var}\,\alpha_{ij} - 2\,\text{Cov}\,(\alpha_{i1}, \alpha_{ij})}}, \; j \neq 1$$

buying power of the importing countries as explanatory variables. In the next section, the estimation procedure and results of the simultaneous model are discussed.

Simultaneous Equation Model

The simultaneous model defined by equations 3.4-3.6 is assumed to have a log-linear form as before. The bilateral export supply function is the same as equation 5.16 and is reproduced below for convenience with the rest of the testable simultaneous model,

$$X^s_{ij} = \alpha^0_{ij} + \alpha^1_{ij} \log P_{xi} + \alpha^2_{ij} \log P_{di} + \alpha^3_{ij} \log CAP_i + \alpha^4_{ij} U + \sum_{n=1}^{4} \alpha^{4+n}_{ij} D_n + \varepsilon^2_{ij} \tag{5.18}$$

and

$$X^d_{ij} = a^0_{ij} + a^1_{ij} \log P_{xi} + a^2_{ij} \log P_{dj} + a^3_{ij} \log Y_j + a^4_{ij} \log P_{xw} + \sum_{n=1}^{4} a^{4+n}_{ij} D_n + \varepsilon^3_{ij} \tag{5.19}$$

$$X^s_{ij} = X^d_{ij} \tag{5.20}$$

where

X_{ij}^{d} is the demand for country i's exports by country j;

P_{dj} is the domestic price index in j

Y_j is the gross national product of j

P_{xw} is the price index of world exports

and all other variables have been defined earlier. The time subscript has been omitted for notational convenience.

The bilateral export supply equation (5.18) was estimated by the two-stage least squares method, correcting for serial correlation where necessary. As in earlier estimations, equations were re-estimated without the adjustment for serial correlation, if ρ was found to be insignificantly different from zero based on an asymptotic t-test. The results are presented in Tables 5.7-5.9 for Korea, Mexico and Taiwan respectively.

As can be seen from the estimated elasticities (β_{ij}^{1}, β_{ij}^{2}, β_{ij}^{3}), no significant improvement in the results was obtained by employing a simultaneous model. The conclusion is, first, that the small country assumption seems to be valid for bilateral exports as well, at least in the case of the three countries

Table 5.7

Simultaneous System Estimation Results:
Bilateral Exports - KOREA

Importing Country	α^0	P_x α^1	P_d α^2	CAP α^3	U α^4	D_1 α^5	D_2 α^6	D_3 α^7	D_4 α^8	Rho
U.S.A	1.080 (1.41)	-0.183* (-2.43)	0.598 (1.76)	0.816* (3.45)	-0.046 (-0.23)	0.148 (4.32)	0.151* (3.88)	0.109* (3.19)	0.239 (1.76)	0.08* (9.77)
Japan	0.935 (0.75)	0.007 (0.07)	0.382 (0.82)	0.988* (3.18)	0.129 (0.48)	-0.263* (-6.01)	-0.137* (-2.74)	-0.098* (-2.25)	-0.031 (-0.17)	0.06* (13.27)
Canada	0.292 (0.19)	-0.423* (-3.77)	-0.588 (-0.76)	1.490* (2.79)	0.802 (1.74)	-0.178 (-1.63)	0.064 (0.52)	-0.120 (-1.12)	0.655* (2.13)	0.11* (4.68)
Germany	-1.940 (-1.61)	-0.244* (-3.35)	0.132 (0.23)	1.332* (3.43)	0.766* (2.23)	-0.001 (-0.01)	0.183 (1.57)	0.052 (0.50)	0.451* (2.00)	0.12* (2.65)
U.K.	-2.401* (-2.16)	0.122 (1.54)	0.396 (0.74)	1.127* (3.04)	0.495 (1.56)	-0.001 (-0.01)	0.059 (0.70)	-0.109 (-1.47)	0.058 (0.27)	0.11* (4.64)

* Significantly different from zero at 95% level of confidence. For α^1, see equations 5.5 to 5.8.

Table 5.8

Simultaneous System Estimation Results:
Bilateral Exports - MEXICO

Importing Country	α^0	P_x α^1	P_d α^2	CAP α^3	U α^4	D_1 α^5	D_2 α^6	D_3 α^7	D_4 α^8	Rho
U.S.A	3.176* (3.24)	0.009 (0.35)	-0.297* (-1.82)	0.468* (1.82)	0.042 (0.28)	-0.031 (-0.78)	-0.026 (-0.60)	-0.205* (-5.53)	0.043 (0.49)	0.13* (1.87)
Japan	6.524 (1.75)	-0.001 (-0.01)	-1.320* (-2.36)	0.139 (0.13)	0.312 (0.62)	-0.272 (-1.38)	-0.571* (-3.03)	-0.207 (-1.12)	-0.299 (-0.87)	**
Canada	-0.201 (-0.05)	0.036 (0.29)	-0.993* (-2.08)	0.892 (0.78)	0.915 (1.92)	-0.021 (-0.13)	0.191 (1.22)	0.061 (0.40)	0.386 (1.30)	**
Germany	5.317 (1.09)	-0.097 (-0.64)	-0.953* (-2.35)	-0.239 (-0.17)	1.243* (2.49)	-0.010 (-0.07)	-0.020* (-2.17)	-0.217* (-1.98)	0.070 (0.28)	**

* Significantly different from zero at 95% level of confidence. For α^1, see equations 5.5 to 5.8.

** Estimated using OLSQ. Upon correcting for serial correlation, it was found that ρ was not significant at 95% level of confidence.

Table 5.9

Simultaneous System Estimation Results:
Bilateral Exports - TAIWAN

Importing Country	α^0	P_x α^1	P_d α^2	CAP α^3	U α^4	D_1 α^5	D_2 α^6	D_3 α^7	D_4 α^8	Rho
U.S.A.	-0.361 (-0.29)	-0.024 (-0.66)	-0.583* (-1.65)	1.748* (12.05)	0.167 (0.87)	-0.121* (-2.77)	-0.012 (-0.24)	0.063 (1.47)	0.074 (0.61)	0.11* (3.50)
Japan	-1.467 (-0.62)	0.073 (1.29)	0.430 (0.64)	0.754* (3.17)	0.336 (0.95)	-0.143 (-1.49)	0.273* (2.65)	0.141 (1.50)	0.222 (1.08)	0.12* (1.74)
Canada	-1.694 (-0.77)	-0.173* (-3.11)	-0.422 (-0.68)	1.316* (5.74)	0.279 (0.85)	0.018 (0.21)	0.175 (1.89)	0.246* (2.95)	0.394* (2.01)	0.12* (2.19)
Germany	-1.573 (-0.98)	-0.099* (-2.52)	0.038 (0.09)	0.937* (5.72)	0.421 (1.75)	0.015 (0.23)	-0.151* (-2.18)	0.041 (0.65)	0.110 (0.78)	0.12* (1.85)

*Significant at the 95% level of confidence. For α^1, see equations 5.5 to 5.8.

examined in this study. Second, there is no evidence to suggest that exports have been biased towards the U.S.A. The coefficients of the uncertainty dummy are insignificant in all cases except for the exports by Korea and Mexico to Germany--and in these cases, the signs of the coefficient indicate a movement *towards* Germany which is not a center country.[66]

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[66]The computation of a t-statistic as defined in equation 5.18 is extremely complex for the simultaneous equation model especially when estimation requires an adjustment for autoregression. Fortunately, because the coefficients of the uncertainty variable were insignificant, this computation was not undertaken. The results were bound to be insignificant. For Germany's imports from Korea and Mexico, the t-statistic would have had the wrong sign in any case, even if it were significant.

CHAPTER 6

SUMMARY AND CONCLUSIONS

The study was conducted to examine the developing countries' claim since the inception of the floating exchange rate system in 1973 that

(1) The increased exchange risk present under floating exchange rates has hampered their ability to export;

(2) The influence of exchange risk is asymmetrically felt in exports to the center country (i.e. to the country to whose currency the developing countries' currencies are pegged) and in exports to all other countries. It was argued that faced with lower risk in their traditional markets, exporters in developing countries would prefer to concentrate their exports to the center country.

Before these claims could be evaluated, two underlying questions needed to be addressed. The first related to the influence of exchange risk on the export decisions of an exporting firm. This micro question has been addressed in the literature either in the context of a domestic firm with no access to futures contracts (which corresponds to the case of an exporter with *no* access to forward exchange markets) or in the context of a trading firm with access to a *perfect* forward exchange market. In addition, previous discussions employed specific utility functions, and therefore, their generalization was questionable.

In Chapter 2 of this study, the influence of exchange risk was analyzed using a general utility function with the only restrictions imposed being that marginal utility is positive and declining ($u'>0$, $U''<0$) and that the firm exhibits decreasing absolute risk aversion. Another important generalization was achieved by allowing the forward exchange market to be imperfect. In this general framework, it was found that a firm's export decision would be influenced by exchange risk. In most developing countries, where overt exchange speculation is generally prohibited and forward markets are imperfect, exchange risk could be expected to have an inverse relationship with exports. The two extreme cases of a non-existent forward exchange market and a perfect forward exchange market become special cases of the general model. Thus, a reconciliation between contradictory conclusions in existing literature was achieved.

Exchange risk has historically been equated with exchange variability (volatility). This approach totally neglects the important role of expectations. It was argued here that inability to forecast future exchange rates (i.e. forecasting error) is a more appropriate indicator of exchange risk. The rationale for rejecting variability as an appropriate measure of risk is, simply stated, that if exchange rates could be forecasted with accuracy a mere increase in volatility would not imply a greater risk. It could be argued that the distinction is trivial because only if exchange rates have a known unchanging and deterministic relationship with other variables (whose future values are known with certainty) is perfect forecasting possible. And because such a situation is unlikely, the distinction is not important. But the issue is one of degree. At times, exchange rates may be easier to forecast than at others, and this relates not to their volatility per se, but to the knowledge of their underlying structure.

Based on this concept of exchange risk (and a few authors have employed it recently), time series analysis was used to obtain forecasts of exchange rates. Forward rates have been used elsewhere as proxies for exchange rate expectations with some success. Several justifications were provided in Chapter 4 for the choice of the alternative method employed in this study. Four proxies for exchange risk were developed, and it was found that exchange risk was considerably larger in the period of floating rates than it had been under pegged rates, by each measure.

This analysis provided the basis for addressing the two central empirical questions raised by the developing countries. The aggregate export markets of India, Israel, Korea, Mexico and Taiwan, and the bilateral export functions for Korea, Mexico and Taiwan were modeled both as single equations and as simultaneous systems to test these two hypotheses.

In the context of aggregate exports, the notion that exchange risk had dampened exports did not have empirical support. The conclusion, in short, is that although exchange risk had increased significantly since the introduction of floating rates and on a theoretical micro level exporters could be expected to reduce exports as a result, there is no empirical evidence to suggest that this did occur. Several interesting possibilities arise from this finding. First, the influence of exchange risk on export levels may be so weak that its effect cannot be identified empirically. Second, it may be that for institutional reasons traders in these countries may be active in both import and export markets, thereby largely neutralizing the effect of exchange risk on exports. Lastly, the currency denomination of export contracts has an important bearing on this issue and may explain why theoretical expectations were not realized in the empirical tests.

Following the line of argument presented in Chapter 3, if exchange risk had a bearing on export levels, then for developing countries that kept their currency's pegged to a major currency, exports could be expected to shift structurally towards this center country. The increase in exchange risk would be asymmetric vis-a-vis the center currency and all other currencies. Because of pegging practices, the increase will be lower for the center currency. In testing for such a shift in the exports of Korea, Mexico and Taiwan, in both a single equation and a simultaneous model, it was found that there was no empirical evidence to support this argument. Once again, the conclusion is not as unambiguous as it may sound. The comments made in the context of aggregate exports apply here also, and the currency denomination of exports contracts could possibly be even more important in the case of bilateral exports.

The unresolved issues, although considered beyond the scope of the present investigation, represent potential areas for future research. When the effects of these institutional and other factors can be identified and their influence on the relationship between exchange risk and export levels measured, an unambiguous answer to the question can be obtained. In the interim, the conclusion must be that there is insufficient empirical evidence to support the hypothesis that the increased exchange risk under floating rates has adversely affected the export performance of the developing countries.

In view of this, it is particularly interesting that exchange rate stability continues to receive increasing attention in international fora, such as the IMF. At the annual IMF meetings held in Belgrade in October 1979, exchange stability was considered to be a pressing issue even by the industrial nations of Europe whose financial and exchange markets are generally posited to be perfect.

APPENDIX A

APPENDIX A

Proposition: Complete hedging will occur if and only if the expected marginal revenue of converting foreign exchange through the future spot market exactly equals the net marginal revenue of conversion through the forward market and the marginal production costs, i.e.

$$\alpha = 1 \text{ } \underline{\text{if}} \quad p\bar{r} = f[1 - C_2'(f)] = C_1'(q)$$

<u>Proof</u>:

$$\pi \equiv \alpha pfq + (1-\alpha)prq - C_1(q) - C_2(\alpha pfq)$$

Adding and subtracting pfq, we have:

$$\pi = (1-\alpha)pq(r-f) + pfq - C_1(q) - C_2(\alpha pfq)$$

From which,

$$\frac{\partial E[U(\pi)]}{\partial \alpha} = E\{U'(\pi)[(1-\alpha)p(r-f) + pf - C_1' - C_2''\alpha pf]\} = 0 \qquad (A1.1)$$

$$\frac{\partial E[U(\pi)]}{\partial \alpha} = E\{U'(\pi)[pq(f-r) - C_2'' pfq]\} = 0 \qquad (A1.2)$$

When $\alpha = 1$, we have, from 1.1,

$$pf[1-C_2'] = C_1' \qquad (A1.3)$$

and from A1.2, noting that $\pi = pfq - C_1(q) - C_2(\alpha pfq)$ when $\alpha = 1$ (i.e. it is non-stochastic), we get

$$\bar{r} \,.\, p/q = p/q \,.\, f[1-C_2'] \qquad (A1.4)$$

or $\bar{r} = f[1-C_2']$

A1.3 and A1.4 together imply that $p\bar{r} = C_1'$.

For sufficiency, we need to show that if A1.3 and A1.4 hold, the hessian:

$$\begin{bmatrix} \frac{\partial^2 E[U(\pi)]}{\partial_q^2} & \frac{\partial^2 E[U(\pi)]}{\partial q\ \partial\alpha} \\ \frac{\partial^2 E[U(\pi)]}{\partial q\ \partial\alpha} & \frac{\partial^2 E[U(\pi)]}{\partial\alpha^2} \end{bmatrix}$$

is negative definite. Specifically, we need to show that the determinate of H_2, $|H_2| > 0$. When A1.3 and A1.4 hold:

$$\frac{\partial^2 E[U(\pi)]}{\partial q^2} = E\{U''[(1-\alpha)p(r-f) + pf - C_1' - C_2'\alpha pf]^2 - U'[C_1'' + C_2''(\alpha pf)^2]\} \qquad (A1.5)$$

$$\frac{\partial^2 E[U(\pi)]}{\partial q^2} = E\{U''[pq(f-r) - C_2'pfq]^2 - U'\ C_2''(pfq)^2\} \qquad (A1.6)$$

$$\frac{\partial^2 E[U(\pi)]}{\partial q\ \partial\alpha} = E\{U''[(1-\alpha)p(r-f) + pf - C_1' - C_2'\alpha pf][pq(f-r) - C_2'pfq] + U'[p(f-r) - C_2'pf - C_2''\alpha p^2f^2q]\} \qquad (A1.7)$$

When $\alpha = 1$, we know from A1.3 and A1.4 that pf $(1 - C_2')$ $= C_1'$, and $\bar{r} = f(1 - C_1')$. Upon substitution, equations A1.5 - A1.7 reduce to:

$$\frac{\partial^2}{\partial q^2} E[U(\pi) = - E\{U'[C_1" + C_2"(pf)^2\} \qquad \text{(A1.5')}$$

$$\frac{\partial^2}{\partial \alpha^2} E[U(\pi)] = E\{U"[(pq)^2 \ (\bar{r}-r)^2 - U'C_2"(pfq)^2\} \qquad \text{(A1.6')}$$

$$\frac{\partial^2}{\partial q \ \partial \alpha} E[U(\pi)] = E\{U'[p(\bar{r}-r) - C_2"p^2f^2q]\} \qquad \text{(A1.7')}$$

Furthermore, at $\alpha = 1$, π is non-stochastic. Therefore, we can write, for equations A1.5' - A1.7',

$$\frac{\partial^2}{\partial q^2} E[U(\pi)] = - U'[C_1" + C_2(pf)^2]$$

$$\frac{\partial^2}{\partial \alpha^2} E[U(\pi)] = U"[(pq)^2\sigma_r^2] - U'[C_2"(pfq)^2]$$

where $\sigma_r^2 \equiv$ Variance of r and

$$\frac{\partial^2}{\partial q \ \partial \alpha} E[U(\pi)] = - U' \ C_2"p^2f^2q$$

respectively.

Finally, the determinant of H_2 is:

$$|H_2| = - U'[C_1'' + C_2''(pf)^2][U''(pq^2)\sigma_r^2 - U'C_2''(pfq)^2] - [U'C_2''p^2f^2q]^2$$

$$= - U' U'' C_1''(pq)^2\sigma_r^2 + (U')^2C_1'' C_2''(pfq)^2 - U' U'' C_2''(p^2f^2q)^2\sigma_r^2$$

$$+ [U' C_2''p^2f^2q]^2 - [U' C_2''p^2f^2q]^2$$

The last two terms cancel out. Since, $U''(\pi) < 0$ and $C_1''(q)$, $C_2''(F)$, $U(\pi) > 0$, we can conclude that $|H_2| > 0$, completing the proof.

APPENDIX B

APPENDIX B

Proposition: The demand for a country's exports to another country approaches perfect elasticity when these exports represent a small fraction of the latter country's aggregate imports.

Proof:[67]

The global demand by country j for a commodity (x) can be stated as,

$$W = X(P_x , P_w) + [W - X] (P_x , P_w) \qquad (A2.1)$$

where,

X is j's demand for country i's exports of commodity x.

W is j's global demand for x.

P_x is i's export price for x.

P_w is export price for x from all other exporting countries.

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[67]The proof is similar to the one provided in Kreinin, M.E., International Economics: A Policy Approach, 3rd ed. (New York, NY; Harcourt, Brace & Jovanovich, 1979) for aggregate exports.

Differentiating A2.1 with respect to P_x,

$$\frac{dW}{dP_x} = \frac{\partial x}{\partial P_x} + \frac{\partial x}{\partial P_w} \cdot \frac{dP_w}{dP_x} + \frac{\partial [w-x]}{\partial P_x} + \frac{\partial [w-x]}{\partial P_w} \cdot \frac{dP_w}{dP_x} \qquad \text{(A2.2)}$$

Multiplying both sides by $\frac{P_x}{X}$ and re-writing terms in the form of elasticities, we get,

$$- \eta_w \cdot \frac{w}{x} = -\eta_x + \eta_{[w-x]} \cdot \frac{[w-x]}{X} + \frac{P_x}{X} \cdot \frac{dP_w}{dP_x} \left[\frac{\partial x}{\partial P_w} + \frac{\partial [w-x]}{\partial P_w} \right] \qquad \text{(A2.3)}$$

where,

η_w is the price elasticity of demand, of j's global imports of x, with respect to P_x, i.e. $- \frac{\partial w}{\partial P_x} \cdot \frac{P_x}{w}$

η_x is the price elasticity of demand for i's exports of x, i.e., $- \frac{\partial x}{\partial P_x} \cdot \frac{P_x}{x}$

$\eta_{[w-x]}$ is the cross price elasticity of demand for other countries' exports of x, i.e., $\frac{\partial [w-x]}{\partial P_x} \cdot \frac{P_x}{[w-x]}$

Rearranging terms, A2.3 may be written as,

$$\eta_x = \eta_w \cdot \frac{w}{x} + \eta_{[w-x]} \cdot \frac{[w-x]}{x} + \frac{dP_w}{dP_w} \cdot \frac{P_x}{X} \quad \frac{\partial x}{\partial P_w} + \frac{\partial [w-x]}{\partial P_w} \qquad \text{(A2.4)}$$

When i's exports of x to j (X) are a very small fraction of j's total imports of X (W), then

$$\frac{W}{X} \longrightarrow \infty \, , \quad \frac{W-X}{X} \longrightarrow \infty \, , \text{ and } \frac{dP_w}{dP_x} = 0$$

It follows directly from these observations that,

$$\eta_x \longrightarrow \infty \quad \text{as } \frac{X}{W} \longrightarrow 0$$

Summing over all commodities exported by i to j, we may conclude that this relationship holds in the aggregate, thus completing the proof.

APPENDIX C

APPENDIX C

For completeness and also to verify the validity of the small country assumption the aggregate export supply function (equation 5.1 and reproduced below as equation A3.1) is estimated in a simultaneous model, with export prices being determined endogenously. The trend in the literature has been towards simultaneous estimation,[68] but it is not clear whether the incremental effort and complexity is justified in terms of the results, i.e. whether the simultaneous approach yielded significantly superior results.

By estimating the export supply equation as both a single equation and a simultaneous system in this study is defined by equations A3.1-A3.3.

<u>Country i's Export Supply</u>

$$\log X^s_{t_i} = \beta_{0_i} + \beta_{1_i} \log XPI_{t_i} + \beta_{2_i} \log DPI_{t_i} + \beta_{3_i} \log_i CAP_{t_i} + \beta_{4_i} R^i_{t_i} + \sum_{n=1}^{4} \beta_{4+n_i} D_n + \varepsilon_{t_i} \qquad (A3.1)$$

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[68] See for example, Hooper, P. and Kohlhagen, S.W., "The Effect of Exchange Rate Uncertainty on the Prices and Volume of International Trade", <u>Unpublished</u>, 1978; Goldstein M. and Khan, M.S., "The Supply and Demand for Exports: A Simultaneous Approach", <u>REStat</u>, March 1977, p. 285; and Grossman, G.M., "A Quarterly Econometric Model of the Exporting Behavior of Some Non-Industrial Countries", <u>Unpublished</u>, MIT, 1978. The last is of particular interest since it is concerned with developing countries.

World Demand for Country i's Exports

$$\log X^d_{t_i} = \alpha_{0_i} + \alpha_1 \log XPI_{t_i} + \alpha_2 \log XPW_t + \alpha_3 \log WXQ_t$$

$$+ \sum_{n=1}^{4} \alpha_{3+n_i} D_n + \eta_{t_i} \qquad \text{(A3.2)}$$

Equilibrium in Export Market of Country i

$$X^s_{t_i} = X^d_{t_i} \qquad \text{(A3.3)}$$

where,

$X^d_{t_i}$ is the world demand for country i's exports in period t;

XPW_t is the price index of world exports in period t;

WXQ_t is real world purchasing power;

η_{t_i} is the stochastic error term;

and all other variables have been defined earlier.

This specification of the demand function for a country's export is similar to that used generally in the literature. Total world exports have been used to measure real world purchasing power for reasons of data availability, although some researchers have argued that it is a preferred measure because it reflects some of the restrictions in trade which world income would not.[69] Quarterly data on income is just not available for most countries.

The export supply functions of the five countries under consideration (India, Israel, Korea, Mexico and Taiwan) were estimated using 2 SLS. An adjustment for serial correlation was made in the initial estimation and an asymptotic t-test conducted on Rho (ρ). Where the null hypothesis, $\rho=0$, could not be rejected, the equations were re-estimated by ordinary least squares (OLS).

The results of the estimation are presented for R^1 and R^2, the two alternative formulations of the uncertainty variable, in Tables A3.1 and A3.2. In the case of India and Korea, serial correlation existed, but for Israel, Mexico and Taiwan, the OLS results are shown because ρ was insignificant at the 95 percent level of confidence.

A comparison of the export supply elasticities derived from simultaneous estimation with those estimated by single equation estimation (Tables 5.1 and 5.2) clearly reveals that no appreciable improvement in the

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[69] Polak, J.J., An International Economic System, pp. 47-51 (Chicago, Ill.; University of Chicago, 1953).

Table A3.1

Simultaneous System Estimation Results - R^1 (Adjusted for Serial Correlation Where Necessary)[1]

$$R_t^1 = \frac{1}{12} \Sigma \left| r_{t-i-1} - r_{t-i} \right|$$

Country	β_0	P_x β_1	P_d β_2	CAP β_3	R^1 β_4	D_1 β_5	D_2 β_6	D_3 β_7	D_4 β_8	Rho
India	-0.575 (-0.59)	0.035* (1.99)	0.239 (1.01)	0.897* (2.06)	-0.613* (-2.25)	0.172 (0.54)	-0.119* (-3.56)	-0.077* (-2.54)	-0.020 (-0.34)	0.319* (2.67)
Israel	0.366 (0.37)	-0.115* (-2.14)	0.358 (2.90)	0.325 (1.01)	-0.243 (-1.39)	0.206* (4.07)	0.029 (0.58)	-0.162* (-3.17)	0.139 (1.87)	**
Korea	-2.030 (-0.90)	0.206* (2.08)	0.287 (0.55)	0.616* (2.76)	-0.004 (-0.61)	-0.240* (-8.70)	-0.036 (-1.12)	-0.074* (-2.59)	0.055 (0.65)	0.957* (26.13)
Mexico	4.003* (8.49)	0.003 (0.10)	-0.409* (-1.75)	0.526* (1.66)	0.085 (1.17)	-0.062 (-1.88)	-0.134* (-3.93)	-0.237* (-7.55)	-0.259 (-0.55)	**
Taiwan	-6.426 (-1.29)	0.191 (0.23)	-0.602 (-0.15)	1.826* (1.65)	0.011 (0.01)	-0.129 (-1.31)	0.001 (0.01)	0.034 (0.27)	-0.155 (-0.15)	**

[1] Aggregate export supply functions. Number in parentheses are t-statistics.

* Significant at the 95% level of confidence.

** Equation re-estimated using OLSQ.

Table A3.2

Simultaneous System Estimation Results - R^2
(Adjusted for Serial Correlation Where Necessary)[1]

$$R_t^2 = \sqrt{\frac{1}{12}\Sigma(r_{t-i-1} - r_{t-i})^2}$$

Country	β_0	P_x β_1	P_d β_2	CAP β_3	R^2 β_4	D_1 β_5	D_2 β_6	D_3 β_7	D_4 β_8	Rho
India	-0.425 (-0.39)	0.030* (1.65)	0.172 (0.74)	0.922* (2.10)	-0.191* (-2.15)	0.016 (0.50)	-0.199* (-3.55)	-0.075* (-2.49)	-0.025 (-0.41)	0.338* (2.85)
Israel	0.295 (0.32)	-0.111* (-2.20)	0.343 (3.25)	0.355 (1.20)	-0.113* (-1.65)	0.209* (4.26)	0.030 (0.62)	-0.163* (-3.31)	0.136 (1.94)	**
Korea	-2.156 (-1.00)	0.188* (2.06)	0.329 (0.66)	0.600* (2.79)	-0.002 (-0.92)	-0.240* (-9.01)	-0.035 (-1.14)	-0.072* (-2.63)	0.053 (0.66)	0.957* (26.17)
Mexico	4.101* (8.94)	-0.007 (-0.23)	-0.319 (-1.47)	0.415 (1.40)	0.029 (0.81)	-0.056 (-1.75)	-0.127* (-3.86)	-0.233* (-7.76)	-0.015 (-0.33)	**
Taiwan	-6.325* (-2.00)	0.195 (0.40)	-0.638 (-0.26)	1.837 (1.08)	0.046 (0.10)	-0.128 (-1.71)	0.001 (0.01)	0.034 (0.37)	-0.172 (-0.30)	**

[1] Aggregate export supply functions. Numbers in parentheses are t-statistics.

* Significant at the 95% level of confidence.

** Equation re-estimated using OLSQ.

results resulted from simultaneous estimation. The conclusion is that, at least for the five countries examined here the small country assumption on the export supply side was appropriate. Unfortunately, there is no justification for a generalization of this conclusion.

APPENDIX D

Table A4.1

Single Equation Estimation Results - R^3
(Adjusted for Serial Correlation Where Necessary)[1]

$$R^3 = \frac{1}{12}\sum^{12}\left|\frac{1}{12}\sum_{j=1}^{12} r_{t-i-j} - r_{t-i}\right|$$

Country	β_0	P_x β_1	P_d β_2	CAP β_3	R^3 β_4	D_1 β_5	D_2 β_6	D_3 β_7	D_4 β_8	Rho
India	- 0.153 (- 0.14)	0.028* (1.72)	0.243 (1.02)	0.796* (1.77)	-0.111* (-1.8)	0.019 (0.56)	0.120* (-3.49)	-0.076* (-2.44)	-0.023 (-0.39)	0.294 (2.44)
Israel	-1.152* (-4.96)	-0.029* (-2.96)	0.166 (2.96)	0.843* (9.22)	0.009 (-0.43)	0.195* (5.99)	0.010 (0.32)	-0.187* (-5.75)	0.072 (1.64)	**
Korea	-2.901 (-1.85)	-0.008 (0.21)	0.594 (1.94)	0.487* (2.75)	-0.001 (-0.09)	-0.235* (-10.69)	-0.022 (-0.88)	-0.54* (-2.45)	0.057 (0.84)	0.965* (29.20)
Mexico	4.202* (16.88)	0.032* (-0.94)	-0.323 (-2.47)	0.396* (2.87)	0.021 (1.17)	-0.054 (-1.79)	-0.127* (-4.15)	-0.234* (-7.76)	-0.016 (-0.40)	**
Taiwan	-7.303* (-17.95)	0.032* (1.84)	0.149 (0.98)	1.272* (16.64)	0.087 (2.17)	-0.116* (-2.87)	0.017 (0.418)	0.052 (1.28)	0.019 (0.30)	**

[1] Aggregate export supply functions. Numbers in parentheses are t-statistics.

*Significant at 5 percent level of significance.

**Estimated using OLSQ. Upon correction for serial correlation, it was found that ρ was not significant at 95 percent level of confidence.

Table A4.2

Single Equation Estimation Results - R^4
(Adjusted for Serial Correlation Where Necessary)[1]

$$R_t^4 = \frac{1}{12}\sum^{12}\left|\sum_{j=1}^{j} r_{t-i-j} - r_{t-i}\right|$$

		P_x	P_d	CAP	R^4	D_1	D_2	D_3	D_4	
Country	β_0	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8	Rho
India	.218 (.19)	.024 (1.41)	.301 (1.25)	.660 (1.44)	-.111* (2.23)	.020 (0.61)	-.125* (-3.72)	-.077* (-2.52)	-.016 (-0.27)	.321* (2.69)
Israel	-1.134* (04.94)	-0.029* (-3.02)	0.195 (3.49)	0.814* (9.02)	-0.020 (-1.10)	0.195* (6.07)	0.011 (0.35)	-0.186* (-5.77)	0.081 (1.84)	**
Korea	-2.959 (-1.91)	0.009 (0.23)	0.603 (1.96)	0.489* (2.77)	0.001 (-0.15)	-0.235* (-10.69)	-0.022 (-0.89)	-0.054* (-0.89)	0.057 (0.84)	0.965* (29.01)
Mexico	4.197* (16.63)	-0.012 (-0.95)	-0.316* (-2.29)	0.390* (2.73)	0.016 (1.02)	-0.054 (-1.78)	-0.126* (-4.11)	-0.232* (-7.70)	-0.015 (-0.38)	**
Taiwan	-7.302* (-17.55)	0.033* (1.86)	0.146 (0.95)	1.276* (16.61)	0.072* (1.97)	-0.119* (-2.93)	0.013 (0.33)	0.051 (1.25)	0.010 (0.15)	**

[1]Aggregate export supply functions. Numbers in parentheses are t-statistics.

* Significant at 5 percent level of confidence.

**Estimated using OLSQ. Upon correction for serial correlation, it was found that ρ was not significant at 95 percent level of confidence.

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