MANAGEMENT OF FOREIGN EXCHANGE RISK: A REVIEW ARTICLE

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Abstract. This paper reviews the literature on Foreign Exchange Risk Management (FERM) which has burgeoned during the last decade. Scholars' and practioners' emerging interest in Foreign Exchange Risk Management was spurred by the advent of fluctuating exchange rates in the early seventies as well as by the pronouncement of the infamous FASB Statement No. 8 in 1976 which laid down unambiguous guidelines for consolidating financial statements of multinational corporations. A normative (rather than a market) view of Foreign Exchange Risk Management is taken and accordingly the author reviews first the two key informational inputs necessary for any Foreign Exchange Risk Management program: forecasting exchange rates and measuring exposure to exchange risk. Available decision models for handling transaction and translation exposures are reviewed next. A concluding section identifies gaps in the existing literature and suggests directions for future research.

INTRODUCTION

> So much of barbarism, however, still remains in the transactions of most civilized nations, that almost all independent countries choose to assert their nationality by having, to their own inconvenience and that of their neighbors, a peculiar currency of their own.
>
> *John Stuart Mill, 1894*

■ Of all the winds of change that have buffeted multinational corporations (MNCs) in recent years, none has had a more pervasive impact upon their risk profile than the demise of the international monetary system of quasi-fixed exchange rates that had prevailed until March 1973 under the Bretton Woods agreement (1944–1971) and, later, under the short-lived Smithsonian accord (1971–1973). A somewhat chaotic system of floating exchange rates has emerged in its stead.

The resulting heightened volatility in currencies' prices has severely disrupted the steadiness of multinational corporations' foreign income streams. The recent implementation of the controversial and inflexible FASB Statement No. 8 has further exacerbated this seemingly erratic earnings pattern by doing away with the former widely used practice of *reserving* for foreign exchange gains and losses and forcing upon MNCs the periodic disclosure of such gains and losses even though no cash flows may be involved.

This unprecedented situation has stirred a considerable amount of interest among both academics and practitioners in Foreign Exchange Risk Management. This article reviews the literature on Foreign Exchange Risk Management published in the last decade to identify the conceptual weaknesses underlying the normative Foreign Exchange Risk Management decision models currently available and to suggest fruitful directions for future managerially oriented research.

MANAGEMENT OF FOREIGN EXCHANGE RISK: WHOSE VIEW?

Foreign Exchange Risk is commonly defined as the additional variability experienced by a multinational corporation in its worldwide consolidated earnings that results from unexpected currency fluctuations. It is generally understood that this considerable earnings variability can be eliminated — partially or fully — at a

cost, the cost of Foreign Exchange Risk Management. Is such a cost warranted or, in other words, should corporate treasurers be concerned with the smooth period-to-period earnings pattern so cherished by security analysts, because a volatile earnings pattern is commonly believed to affect the firm's price-earnings ratio and, in turn, its ability to raise funds at a reasonable cost?

Modern capital market theory, which defines foreign exchange risk as "the systematic risk associated with a foreign currency denominated return (or cost) stream and measured by the covariance between the rate of change of the exchange rate and the domestic market return" [80, p. 25], answers in the negative. It argues that under certain assumptions of market efficiency (to be spelled out below) Foreign Exchange Risk Management is totally superfluous. This somewhat extreme point of view, detailed in Logue and Oldfield [48], holds that a firm's risky prospects are valued directly by the market on the basis of their expected profitability and their systematic risk (that is, the risk which cannot be "diversified away"); thus, it should make "no difference to the valuation of either the total market portfolio or the individual firm whether exchange risks...are passed through to the capital market as part of the risk of the firm's shares, or 'laid off,' or transferred directly to the market through forward exchange or foreign currency debt contracts."[1] In this somewhat hypothetical world, MNCs' treasurers abdicate the initiative of Foreign Exchange Risk Management whose responsibility is fully transferred to the firm's shareholders who, in turn, will manage the unsystematic portion of exchange risk through efficient portfolio diversification. The relevant question for scholarly investigation thus becomes that of exchange risk diversification from the viewpoint of the investor selecting claims on firms located in different countries or operating across national boundaries (MNCs), claims which are clearly denominated in different currencies. Normative research efforts in this direction are aimed at extending the Capital Asset Pricing Model to a multicurrency world; however, existing International Capital Asset Pricing Models are based on extraordinarily restrictive assumptions. To wit, Fama and Farber [24] and Grauer, Litzenberger, and Stehle [33] assume away international capital market segmentation (that is, international capital markets are fully integrated). The former model presumes further that investors consume only one homogeneous good and that Purchasing Power Parity holds at all times. Solnik [72 a & b] similarly assumes full integration of international capital markets but allows for different consumption goods across countries; however, exchange rates are assumed to be uncorrelated with the corresponding local currency market returns, certainly a convenient simplifying premise. In sum, all three models acrobatically dispose of the exchange risk factor in their pricing of foreign currency denominated assets.

How to diversify exchange risk effectively at the investor level remains an unanswered question because existing International Asset Pricing Models require satisfaction of a strict set of conditions which are far removed from the current multicurrency institutional environment facing international investors. Therefore it should come as no surprise that most theoretical models of Foreign Exchange Risk Management and certainly all of current management practice have considered exchange risk from the viewpoint of a firm's treasurer aiming at minimizing the impact of exchange rate fluctuations upon earnings measured in some relevant numeraire, thus upholding the fundamental hypothesis behind Foreign Exchange Risk Management stated at the beginning of this section. Adoption of the firm total risk viewpoint is further warranted, as Makin [50b, p. 521] argues, when

consideration is given to the time horizon of a typical manager which is likely to be considerably shorter than the time period required for the impact of exchange market disturbances on firm's profit to net to zero. Further, costs of capital can be influenced by the perceived riskiness of claims on multinationals and that perceived riskiness, relative to other multinationals, could be altered in the short run by heavy exposures in foreign currencies.

In a similar vein, Aliber [3, pp. 134–135] writes: "The question is whether the firm or individual investor can do a more effective job of diversifying against exchange risk . . . The firm may have superior knowledge, and may be able to protect itself against these risks at lower costs."

Indeed, to the extent that individual investors face exchange controls, high transaction costs, and taxation, MNCs, because they can lessen the burden of such market imperfections, are superiorly equipped to carry out currency diversification on behalf of their shareholders.

Having explained the logic behind the relevance of corporate Foreign Exchange Risk Management, this discussion next proceeds with a review of available methodologies for generating the two key informational inputs for effective Foreign Exchange Risk Management; namely, reliable probabilistic forecasts of future spot exchange rates as well as a projection of corporate exposures on a currency-by-currency basis.

FORECASTING EXCHANGE RATES

Although tremendous resources have been directed at forecasting exchange rate changes or establishing the irrelevance of such forecasting efforts (Market Efficiency hypothesis), little attention has been focused on the managerially more relevant issue of relating the forecastability of foreign exchange rates to Foreign Exchange Risk Management proper. Accordingly, this section will consider first, at some length, the general question of exchange rates forecasting independently from the praxis of Foreign Exchange Risk Management before attempting to reconcile the two.

The quantitative dimension of foreign exchange rates forecasting — that is, predicting expected future spot exchange rates — is traditionally emphasized by most forecasting models. However, the operational value of such predictions can be greatly enhanced if they can be supplemented by a qualitative forecast. Historically, parity changes have, in most cases, been tightly intermingled with a complex history of exchange restrictions running the gamut from selective controls on capital account transactions to indiscriminate controls on all exchange transactions.

The task of the currency forecaster is therefore twofold: (1) quantifying the magnitude of expected exchange rate changes (devaluations or revaluations in the context of pegged exchange rates; depreciation or appreciation in the context of floating exchange rates), and (2) anticipating the likelihood of imposition of exchange controls.

Forecasting Pegged Yet Adjustable Exchange Rates

The current international monetary system is best described as a system in which currencies within major trading blocs maintain their former pegged yet adjustable relationships with each other, but fluctuate continuously — or float in unison — against the currencies of the other major blocs. The European Monetary System, for example, is very much resurrecting, on a regional basis, the Bretton Woods system of quasi-fixed exchange rates through its tightly knit grid of par values.

Under such conditions, forecasting discrete change in parities is a relatively easy task, at least in direction if not in magnitude or timing. Jacque [39a, chapter 4] developed a four-step forecasting model.[2] First, through a review of selected economic indicators, the forecaster will identify which countries have balances of payments that are in fundamental disequilibrium. Second, for the currencies of such countries, the forecaster will measure the pressure that market forces are exercising on prevailing exchange rates. Third, the level of central banks' foreign exchange reserves gives an indication of the future point in time at which the central bank will no longer be in a position to defend the prevailing exchange

rate. The fourth and crucial step is to predict the type of corrective policies that politically motivated decision-makers are likely to implement: will the country under pressure adjust through a manipulation of its exchange rate (devaluation or revaluation) or, instead, initiate, essentially for political reasons, deflationary or inflationary policies combined with exchange controls and extensive international borrowing?

An interesting attempt by Folks and Stansell [28] and Murenbeeld [53], based on the use of multivariate discriminant analysis, was made at identifying the likelihood and direction of potential changes in par values of countries maintaining pegged exchange rates (steps one and two of the above forecasting procedure); however, the forecasting outputs of such models is of limited value because they fail to provide any information as to the timing or magnitude of a potential exchange rate change.

For controlled exchange rates, black market rates will prove to be helpful leading gauges of subsequent devaluation of official (controlled) exchange rates. As a rule, the black market rate (generally available from *Pick's Currency Yearbook and Reports*) depends on the extent to which the official exchange rate overvalues the equilibrium exchange rate as well as on the extent to which illegal transactors (black marketeers) are apprehended and prosecuted. Indeed Culbertson [14] has shown that for an overvalued (controlled) exchange rate, the hypothetical equilibrium exchange rate will fall somewhere between the official and the black market rate.

Forecasting Floating Exchange Rates: Market-Based Forecasts	The return in early 1973 to floating exchange rates by a number of major currencies has generated considerable interest about the general question of whether foreign exchange markets do indeed constitute efficient markets. If clearly established, the Market Efficiency hypothesis would have far-ranging forecasting implications and could possibly establish the irrelevance of building elaborate forecasting models, but, before this critical last point is further elaborated, a careful statement of the efficient markets hypothesis is in order.

A foreign exchange market in which exchange rates always fully reflect all available information is said to be efficient.[3] Three degrees of Market Efficiency are customarily distinguished:[4] (1) the weakly[5] efficient market hypothesis says that series of historical exchange rates contain no information which can be used to forecast future spot exchange rates; (2) the semistrong version of market efficiency holds that a large and competitive group of market participants have access to all publicly available information relevant to the formation of expectations about future rates; finally, (3) if the set of available information also includes private or insiders' information, the market is said to be strongly efficient.

Let us now review the evidence for and against the efficiency of the foreign exchange market and explain the forecasting implications of the hypothesis. Tests of market efficiency have been characterized by the heterogeneity of the statistical tools used as well as of the sample periods and currencies selected. Furthermore, the testing methodologies used have generally been directly borrowed from analogous empirical studies of the stock markets and commodity futures markets, although it is not clear that they are appropriate for testing the efficiency of foreign exchange markets given the presence of major, nonprofit-maximizing participants, namely central banks. Finally, the lack of a comprehensive testing of an exhaustive and uniform data basis clearly precludes reaching clear cut conclusions for or against the efficiency hypothesis.[6]

Weak-form tests have received the most attention, probably because they are the easiest to carry out. These tests are concerned with two major issues: the extent of statistical dependence of successive changes in exchange rates and the profitability of trading rules. In essence, what is being investigated is whether past

series of exchange rates contain useful information for the prediction of future spot prices, thus implying that general patterns would repeat themselves at regular intervals.

The assertion that current exchange rates reflect all publicly available information, as called for by the semistrong form of Market Efficiency, is so general that it has proven a difficult hypothesis to test empirically. Accordingly, empirical evidence for or against this form of market efficiency has been scant except for one recent study by Rogalski and Vinso [63] which provided conclusive evidence in its support.

Another forecasting model that has lately received increasing attention and that is intuitively consistent with the semistrong form of the Market Efficiency hypothesis concerns the predictive accuracy of forward exchange rates. Speculators who think that the forward rate is above their expectation of the future spot exchange rate will sell the foreign currency forward, thus bidding down the forward rate until it equals the expected future spot rate. Conversely, speculators who see the forward rate undervaluing the expected future spot rate will buy foreign currency forward, thus bidding the forward rate up until forward and expected future spot exchange rates become equal. If speculative demand for forward contracts were infinitely elastic and all speculators held homogeneous expectations with respect to the future spot exchange rate, the current forward exchange rate would be equal to the expected future spot exchange rate.

A number of theoretical arguments have been developed to establish that the forward exchange rate must necessarily be a biased predictor of the future spot exchange rate.[7,8] For instance, this simple forecasting model stands in apparent contradiction to the Modern Theory of forward exchange rates determination,[9] which generally suggests that the speculators' schedule is less than infinitely elastic and that, as a result, the equilibrium forward rate of exchange would be different from the future spot exchange rate. Only in the polar case (somewhat unrealistic) of risk-neutral speculators should the forward exchange rate be considered as an unbiased predictor of the future spot exchange rate.[10]

Extensive empirical testing of the Market Efficiency hypothesis, very ably surveyed by Kohlhagen [41a], has generally suffered from the joint hypothesis problem identified by Levich [45a]. Prominent studies include those of Poole [60], Dooley and Shafer [15], Giddy and Dufey [31], Logue and Sweeney [49], Cornell and Dietrich [13], Roll and Solnik [64] and Kohlhagen [41c], whose detailed critical evaluation is beyond the scope of this paper.

For fairly obvious reasons little attention has been devoted to the problem of long-term foreign exchange rate forecasts which are a much needed informational input into the selection of an optimal currency denomination for long-term debt financing or the even more puzzling question of debt refunding/debt refinancing in a multicurrency context.

The relationship between the term structure of interest rates and exchange rate expectations was explored by Porter [61]. The theoretical framework developed in this seminal study showed how the term structure of international interest rates can be used to make inferences as to the expected time path of the exchange rate adjustment between two currencies. This approach was subsequently operationalized very elegantly by Dufey and Giddy [17].

Econometric Modelling Approaches

Exchange rates econometric forecasting models are a systematic effort at uncovering a functional relationship between a set of explanatory (exogenous) variables — such as, price levels differential, interest rates differential, or differential in the rate of growth in money supplies — and a dependent (endogenous) variable — namely, the exchange rate. The functional relationship may involve only the current period values of the exogenous variables or may be of a lagged na-

ture; that is, incorporate past periods values taken on by the exogenous variables. In this latter case econometric modelling is clearly inconsistent with the Market Efficiency hypothesis whereas in the former case it is not necessarily so. As a matter of fact, one may be tempted to argue that econometric forecasting disregarding lagged functional relationships is assisting the market in correctly interpreting all currently available information, thus making it more efficient.

The specification of the model itself — that is, the nature of the functional relationship (not necessarily linear) — as well as the choice of exogenous variables included generally blends economic theory (for example, a combination of the Purchasing Power Parity and Fisher theories) with the model builder's experience and intuition. In that sense, econometric building is as much an art as a science and accordingly the reader should expect the various forecasting services to be idiosyncratic.

Structural equations however (usually one for each currency forecasted) are extracted from time series of exogenous or endogenous variables — that is, from past observations. This means that if a drastic change in the structural relationship between independent and dependent variables were to occur and be disregarded in specifying functional relationships, the econometric model forecasting value would be adversely affected. Thus, if one accepts that the behavior of private and public market participants was markedly affected by the advent of floating exchanges rates, it is perhaps too early to forecast currency prices in the context of a floating exchange rates regime. The reason is that the observations available are still too few and far between (spanning only the 1973–1979 period) to derive meaningful functional relationships between exogenous and endogenous variables. Yet a number of econometricians have apparently felt otherwise because there are at least a dozen major econometric forecasting services that can be subscribed to for a fee.

One last additional feature of econometric forecasting models worth commenting upon is the random error term that is always incorporated in this type of model.[11] The inclusion of such a stochastic element allows probability statements to be made about the forecasted variable. This is indeed an attractive feature compared with a point estimate (as provided, for instance, by forward exchange rates) especially when it is recalled that the information is to be used in a risk management context. However, for econometric forecasting to be theoretically correct, several requirements must be met.[12] The major theoretical flaw of current forecasting efforts is probably the normality assumption (of exchange rates probability distribution) which is generally made. That exchange rates are not normally distributed has been established beyond doubt with Westerfield [77] and Vinso and Rogalski [76] providing empirical evidence to the effect that exchange rates are best described as non-normal members of the Pareto-Levy class of probability distribution.

As could be expected, there is some controversy as to the reliability of such econometric forecasts: in a recent examination of the track record of 6 major econometric forecasting services, Goodman [32] found that

The predictive accuracy of most — not all — of the economics-oriented foreign exchange rate forecasting services is so poor that they are likely to be of little use for corporations trying to manage their foreign exchange exposure.

The results are quite different for the technically-oriented services. Their consistently very strong predictive performance supports the view that speculative runs do occur in the exchange market and that the foreign market is not efficient.

However, Goodman's testing methodology is questionable given that his comparative criterion allows subscribers to economics-oriented forecasts to act only on the last day of the month; by contrast, subscribers to technically-oriented forecasting services are assumed to act on the day the forecast is received.

By contrast, a thorough and up-to-date appraisal of 9 forecasting advisory services by Levich [45c] indicates that some services have consistently beaten the forward rate and that the record of forecasting accuracy was too good to be explained by chance. These results are all the more interesting as they were established by a Chicago-trained economist whose doctoral effort was largely focused on establishing the efficiency of the foreign exchange market [45b].

Addressing himself to the more fundamental question of why a small but vigorously successful forecasting industry is competing with "free" market-based forecasts available daily from the financial press, Makin [50c] appropriately remarks that such ex post empirical evaluation of the accuracy of forecasting services is redundant. Indeed, the true market test is whether forecasters can coexist with the "free" market forecast and incur positive information gathering and processing costs while charging for their services a fee which allows them to earn a competitive rate of return. However, it would be surprising that the output of a permanently superior forecasting model be available commercially; in fact, a recent survey by Evans, Folks, and Jilling [21] indicated that 58.4 percent of the respondents felt that currency forecasting was the weakest link in their exchange risk management programs. One suspects that treasurers place only limited faith in commercially available forecasts but find them helpful for bureaucratic hedging purposes.

In sum, the lack of decisive answers to the general question of forecasting exchange rates remains probably the single most potent justification for undertaking costly, and at times highly constraining, protective policies against foreign exchange risk. More specifically, Dufey and Giddy [17] distinguish between two basically different forecasting situations:

Forecasting and Foreign Exchange Risk Management

(1) The foreign exchange market is efficient (floating exchange rates); the use of market-based forecasts is advocated. However, it should be recognized that the market's expected value will seldom be attained (that is, the actual exchange rate will generally differ from the one actually predicted by the forward exchange rate), hence the need to plan or attempt to forecast errors which are expected to occur. Further, it becomes imperative to assess what would be the impact of such unanticipated deviations from the expected rate on the net cash flows of the firm. (See the section on Managing Economic Exposure.)

(2) The foreign exchange market is inefficient because of stifling government controls on interest rates and exchange rates (pegged yet adjustable exchange rates); multinational corporations should aim at capitalizing on the profit opportunities available because of market distortions in order to offset the cost of operating under government controls in real factor markets.

An operationally viable—if conceptually weak—measure of exposure to foreign exchange risk is provided by accounting rules. A convenient dichotomy generally distinguishes between transaction and translation exposures.

MEASURING EXPOSURE TO FOREIGN EXCHANGE RISK

Wihlborg [79b] defines transaction exposure as an uncertain domestic currency value of an open position denominated in a foreign currency with respect to a known transaction; that is, a future foreign currency denominated flow. As expected, fluctuations in the exchange rate relationship over the life of the contract will result in windfall cash flow gains or losses with tax implications which are not necessarily symmetrical between gains and losses nor consistent across different types of underlying transactions. Jacque developed a simple exposure netting algorithm [39a, chapter 5] on an after-tax basis for subsidiaries of a multinational corporation which are not subjected to homogeneous tax laws with respect to exchange gains and losses.[13]

Transaction Exposure

Translation Exposure

Foreign market entry through direct investment, by contrast, results in so-called translation exposure which Wihlborg [79b] defines as the uncertain domestic value of a net accounting position denominated in a foreign currency at a certain future date: that is, a future foreign currency denominated stock. The practice of periodically consolidating or aggregating parent's and affiliates' balance sheets will generally entail exchange gains or losses of a non-cash flow (paper) nature as exchange rates fluctuate over the accounting horizon. At the core of this consolidation process which allows multinational corporations to disclose earnings valued in a single numeraire (reference currency) lies the controversial question of how balance sheet accounts of foreign subsidiaries ought to be translated. Should the accounts of foreign subsidiaries be treated as exposed or non-exposed items — with exposed items translated at current exchange rates and non-exposed items translated at historical rates? Until 1976 (which marks the implementation of FASB Statement No. 8) multinational corporations were left free to use whatever methods they believed reflected most accurately their true economic performance. Most firms used either the current/non-current, monetary/non-monetary, or current method of translation, and there is an over abundance of accounting literature debating the merits and demerits of each method (cf. Hayes [36], Barrett and Spero [7], Olstein and O'Glove [57], and Pakkala [58], among the most prominent papers).

The mandatory translation guidelines put forward by Statement No. 8 (and subsequently No. 20) eliminated much of the flexibility that U.S.-based multinational corporations previously had in translating their foreign affiliates' financial statements into the reference currency. The most dramatic and perhaps most controversial ruling of Statement No. 8 is that exchange gains or losses resulting from both the conversion and translation processes are to be included in the net income for the accounting period in which the exchange rate change actually occurred. The distinction between realized and unrealized gains and losses was thus unequivocally discontinued as was the use of reserve accounts aimed at mitigating the erratic impact of exchange gains or losses on the earning profile. (For constructive suggestions on how such accounts could be reenacted see Ankrom [4a].) Also controversial are the provisions calling for the treatment of long-term debt as an exposed item (which led a number of U.S.-based MNCs' affiliates to shun local currency long-term funding in favor of dollar-denominated financing) whereas inventory would generally be considered as non-exposed. As a whole, Statement No. 8 has been severely criticized in a flurry of articles appearing in accounting magazines and journals. (See for instance Shank [67], Rodriguez [62a], and Aggarwal [1] for a limited but representative sample of the literature.) If Statement No. 8 has generally been received with skepticism by accountants, treasurers of U.S. multinational corporations have vehemently opposed it as surveys conducted by Choi, Lowe, and Worthley [11] and Stanley and Block [73] clearly establish. A major study commissioned by the FASB (Evans, Folks, and Jilling [21]) further reports that the implementation of Statement No. 8 resulted in increased Foreign Exchange Risk Management activities especially by firms which relied on translation methods most at variance with the guidelines laid down by the new ruling.

The logical consistency of segmenting foreign subsidiaries' financial statements between exposed and non-exposed categories has been questioned by Aliber and Stickney [2] who argue that if the Fisher effect holds, monetary items (generally treated as exposed items) are essentially non-exposed as cumulative interest revenue (exposure) over the maturity of the monetary asset (liability) and would offset the exchange loss (gain) from changes in the exchange rate. By contrast, treating non-monetary items as non-exposed items essentially assumes that Purchasing Power Parity will hold, which will generally not be true in the short term. At the close of 1980, new controversy is about to be injected into this ongoing de-

bate about what constitutes the optimal set of translation rules as the FASB is considering for adoption a new exposure draft which would supersede Statement no. 8. The new proposal would (1) impose the use of an all-current (or closing) rate method and (2) differentiate between transaction and translation gains or losses.

The first proposal would require all balance sheet accounts to be translated at the exchange rate prevailing at the time the consolidation is carried out; income statements would be translated at the average exchange rate for the reporting period.

Second, only transaction gains and losses (both realized and unrealized) would be charged to current income. By contrast, translation gains and losses would be accumulated in "a separate component of stockholders' equity." This is a major departure from FASB No. 8 rule and should reduce considerably the volatility in reported earnings. Although the new exposure draft should be welcome by U.S. multinationals, it is in clear contradiction with the concept of historical cost accounting. Finally, the use of an all-current rate method for translating the balance sheets of overseas subsidiaries operating in hyperinflationary economies which do not use inflation accounting would clearly lead to exchange losses distorted beyond reason; overall, Giannotti and Walker [29] expect the new exposure draft to have a positive impact on the financial practices of multinational corporations as corporate attention is diverted from translation to transaction exposure management and foreign affiliates' financing is sourced from local currency denominated sources (rather than dollar denominated sources).

Economic Exposure

Although widely used, this accounting concept of exposure to foreign exchange risk is, by definition, misleading, because it fails to incorporate the longer-term impact of exchange rate changes on the economic valuation of the multinational corporation. Accordingly, Heckerman [37] outlines a net discounted cash-flow approach to the economic valuation of the foreign subsidiary of a multinational corporation but fails to recognize that future cash flows are themselves a function of exchange rates. A seminal paper by Dufey [16a] showed that exchange rate changes will predictably affect the nominal cash flows of the subsidiary of a multinational corporation; however, the net impact of such a devaluation or revaluation will not necessarily match in direction nor in magnitude the percentage change in the exchange rate. For example, a subsidiary operating in a devaluing country may find itself benefitting rather than suffering from such a devaluation if part of its revenues are derived from export sales.

A more systematic analysis of the impact of exchange rate changes on the foreign subsidiary's sourcing costs and sales revenue is found in Shapiro [68a]. On the revenue side, he distinguishes between domestic and foreign sales cash-flows whereas on the cost side he identifies three partially substitutable inputs: namely, non-traded domestic goods and services, traded inputs, and imported goods.

Shapiro correctly concludes that economic exposure will be determined by the sector of the economy in which the subsidiary operates. As expected, the impact of changing exchange rates will markedly differ for export-oriented subsidiaries, strictly domestic-oriented subsidiaries facing no import competition, or subsidiaries meeting the challenge of stiff import-competition. [14]

Both Dufey's and Shapiro's papers fail to incorporate in their analyses the financial sector nor do they envision the potential use of currency denomination of debt for the purpose of neutralizing the economic exposure stemming from the real sector. Furthermore, the concept of economic exposure is strictly applied to the foreign subsidiary of a multinational corporation and generally assessed in nominal rather than real terms. The concept of economic exposure is obviously just as applicable to a strictly domestic firm (that is, selling to and procuring from

domestic markets) which may find itself exposed, in spite of itself, to the vagaries of the international economy.

In a largely taxonomic paper, Wilhborg [79b] questions the relevance of an indiscriminate concept of economic exposure to foreign exchange risk by noting that there is no exposure when inflation is neutral and exchange rates are determined by the Purchasing Power Parity hypothesis. Indeed, real exposure will occur when inflation is not neutral (relative prices change with inflation and/or relative prices change with the exchange rate) and exchange rates deviate from their Purchasing Power Parity equilibria. The case of relative prices (including terms of trade) changing with the exchange rate is examined in depth by Shapiro [68a].

Cornell [12] concurs with this dichotomy between nominal and real cash flows by showing that, in a world in which exchange rates adjust instantaneously (Purchasing Power Parity holds at every point in time), there is, in real terms, no exchange risk as long as relative prices remain constant; thus, if contractual commitments in nominal terms are avoided (that is, contracts are written in terms of the price index), the firm will no longer be exposed to foreign exchange risk. By contrast, relative price risk remains the fundamental source of risk to which firms are exposed and it is equally faced by domestic and multinational corporations. Whether Purchasing Power Parity does hold is an empirical and controversial issue which has been extensively tested as illustrated in the comprehensive review article by Officer [56]. However, this theoretically attractive concept of economic exposure is difficult to turn into an operational index of exposure to exchange risk which could be readily used for Foreign Exchange Risk Management purposes.

THE MANAGEMENT OF FOREIGN EXCHANGE RISK

Normative models for Foreign Exchange Risk Management are few and far between and one cannot help but contrast the sparsely populated research space of international corporate finance (of which Foreign Exchange Risk Management is only one albeit major subset) with the overly prolific research effort in Market Efficiency testing (as applied to the foreign exchange market). The dichotomy between transaction exposure covering and translation exposure hedging will again provide a convenient framework for organizing our review.

Covering Transaction Exposure

Transaction exposure can be covered either through the use of forward contracts (available only for major trading currencies) or a combination of spot and money market transactions. If Interest Rate Parity fails to hold,[15] each option should be computed and the optimal covering route should be compared with the expected cost/revenue of retaining as uncovered the transaction exposure. This naive expected value criterion is discussed in Jacque [39a, chapter 7] and somewhat elaborated by Calderon-Rossel [10] who fails to recognize that both covering routes are fully consistent with the Interest Rate Parity theorem and certainly entail no residual randomness. If covering is to be undertaken on a recurring basis, Giddy [30b] questions the wisdom of such a practice as — over the longer run — the forward rate tends to be an unbiased predictor of the future spot exchange rate.

The case of contingent transaction exposures (resulting from competitive bidding) denominated in foreign currency is examined by Feiger and Jacquillat [26] who suggest covering such exposures through a combination of a forward sale contract and a foreign exchange call option; however, a market for call and put foreign exchange options has yet to materialize.

For the management of a vector of i transaction exposures, Kohlhagen [41b] develops a decision-theoretic payoff $(N)^{i-1} \times (N)^{i-1}$ matrix of profits over all sets of possible exchange rates (each currency can take N different values) and over all strategies (each of which is optimal for one set of future exchange rates). From

such a payoff matrix, for a "conservative" firm aiming at protecting cash flows, a simple maximin strategy will be derived whereas a more aggressive firm will pursue a maximax strategy. Although theoretically inferior (no formal treatment of decision-makers' risk preference, no attempt at recognizing the statistical relationships among the exchange rates in which the transaction exposures are denominated), this model is appealing from a managerial point of view because it requires for informational inputs only estimates of reasonable ranges of future exchange rates rather than specific exchange rate projections with associated probability distributions.

In a seminal paper, Folks [27b] questions the validity of the cover/not cover paradigm and suggests that an optimal level of retained uncovered exposure can be found analytically by postulating a utility function as describing the risk preference of the decision-maker.[16] In a similar vein, Wheelwright [78] discusses the practical transaction exposure problem faced by a "big-ticket" item exporter. A preference curve is developed that explicitly shows the tradeoffs that the decision-maker is willing to make between the risk surrounding an uncertain situation and an amount to be received with certainty. The reader is left uncertain, however, as to how this preference curve should be derived; namely, what choice of a utility function is to be made for encoding the risk preference of the decision-maker? Preliminary empirical evidence on risk-preference of treasurers of MNCs is provided by Rodriguez [62b] who found asymmetrical attitudes toward foreign exchange risks.

Apportioning of exchange risk in bilateral transactions is generally thought to be achieved better by denominating the transaction in a third currency or mix of third currencies (artificial currency units) rather than by resorting to a combination of the domestic currencies of the two contracting parties. Using an expected utility framework of nominal return (cost), Schwab and Lusztig [65] show that the contracting parties will always achieve a superior sharing of exchange risk by limiting themselves to a combination of their own currencies. Thus, the use of a third currency or of artificial currency units such as SDRs, EURCOs, EUAs, or ARCRUs should be discouraged.[17] Only if the variability of real (rather than nominal) returns (costs) is to be minimized should bilateral transactions be denominated in third currencies or so-called "currency cocktails."

For a set of transaction exposures denominated in different currencies, Makin [50b] derives an efficient frontier of optimal portfolios of shares of exposures to be covered in a traditional mean-variance framework. Exchange rates are assumed to be normally distributed and the matrix of variance-covariance for future exchange rates available and stable. Although not stated, this model assumes the utility of the decision-maker to be quadratic. In a theoretical paper Levi [44a] shows that in a world where the matrix of cross-elasticities between exchange rate changes is fully known at the outset of the exposure horizon it is possible to fully cover the entire portfolio of transactions exposure through only one forward contract; this may perhaps explain why forward markets appear at times to be underutilized. Yet cross-elasticities between foreign currency movements are stochastic rather than deterministic thereby limiting the operational value of this approach.

The economic exposure problem of a trading firm which imports commodities for local sale is investigated by Hodder [38]. The mean-variance model developed by that author traces the optimal level of forward cover to be sought by the importer to the correlation between the local currency price of the imported commodities (in inventory) and the exchange rate (in which the accounts payable are denominated). This is the question of "currency pass-through" which economists are concerned with in attempting to explain balance of payments adjustment (or lack thereof) to changing exchange rates.

For affiliates of multinational corporations operating in hyperinflationary econo-

mies (underdeveloped countries), foreign short-term financing will generally result in major transaction exposure management challenges. Effective costs formulae reflecting anticipated exchange rate devaluations were developed by deFaro and Jucker [25] and Shapiro [68b] on an expected cost basis generally allowing for selection of the optimal source of financing on the basis of linear simulations of exchange rates devaluations. The technique of swap loans popular with a number of Latin American central banks allows the borrower to shelter loan principals from potentially large devaluation (see Eiteman and Stonehill [20]). None of these studies consider, on a risk adjusted basis, what would be the optimal portfolio of short-term financing sources as opposed to the cheapest borrowing source as determined on an expected cost basis.

Hedging Translation Exposure

The essence of hedging is to substitute, at the outset of the exposure horizon, a known cost of buying protection against foreign exchange risk for an unknown translation loss. In a sense, the hedger is trading the uncertainty of an accounting loss which may never materialize for the certainty of eliminating translation risks — a cost that bears some resemblance to an insurance premium. Thus, the rationale behind the concept of hedging is to substitute for exchange losses, footnoted in reported earnings statements, normal business costs (such hedging costs may include a substantial cash flow loss/gain component) that flow through the income statement.

The mechanics of hedging are set forth in Jacque [39a, chapter 9] who shows that, contrary to the widely held view, hedgers are not speculators but covered interest arbitragers in disguise. Liaeter [47a & b] develops a mean-variance framework which allows the hedger to find "a combination of financing and hedging operations that minimizes expected costs and strategy risk and does not violate a set of recognized operational constraints." Strategy risk is a combination of two types of risk — the business risk measures the risk generated from relying on future financing and hedging possibilities which are not known with certainty. The second strategy risk, the devaluation risk, is a combination of risks arising from "the possibility of wrong estimates in devaluation probabilities and devaluation amounts." This one-period (extended by Liaeter to a multiperiod model in [47b]), two-currency world model fails to recognize explicitly the possibly onerous cash flow cost component of pursuing an optimal hedging policy. Last but not least, Liaeter makes two assumptions in flagrant violation of accepted international financial economics: interest rates are independent of expected parity changes and exchange rates in various currencies are assumed to be uncorrelated. The former assumption ignores the Interest Rate Parity hypothesis whereas the latter assumption contradicts the underlying rationale of the portfolio approach to Foreign Exchange Risk Management.

Folks [27a] compares a mean-variance, minimax, expected monetary value and expected utility criteria as a basis for deriving an optimal hedging strategy when available Foreign Exchange Risk Management techniques are adjustment of fund flows, forward contracts, and exposure netting. None of these studies recognize that if the total cost of hedging is known with certainty at the outset of the exposure horizon, the mix of translation gains/losses plus cash flow losses/gains remains stochastic. An attempt at remedying this flaw is provided by Jacque [39b] who formulates an expected utility theoretic hedging model under an explicit chance constraint on the maximum cash-flow cost of hedging.

The only serious attempt at considering the set of translation exposures denominated in various currencies (held by a multinational corporation in the normal course of business) as a portfolio of statistically interdependent (correlated) elements is found in Gull [35] who formulated the optimization problem in a one-period mean-variance framework which fails to distinguish the (random) cash-

flow component of hedging costs from unrealized (paper) translation losses. The major difficulty with such portfolio models is in generating the key informational input; namely, the variance-covariance matrix of exchange rate changes. Gull uses historical information to derive such a matrix in order to generate the optimal vector of pro forma residual exposures, thus implicitly assuming that the covariability structure of past exchange rate changes can be safely extrapolated into the next period. Finally, as with all normative hedging models no attempt is made at capturing the randomness of pro forma translation exposures which may be potentially as serious a source of risk as exchange risk itself.

The problem of selective hedging in a multi-period setting is solved by Shapiro and Rutenberg [69a]. The stochastic dynamic programming algorithm is formulated under somewhat restrictive assumptions. Given current hedging costs, expectations of future hedging costs (both of which are assumed to be linear) should a treasurer hedge a future period or should he wait? Hedging of a future period can be achieved by selling the suspect currency forward for τ periods and buying it forward for (τ-1) periods. One or several (discrete) devaluations are assumed throughout the exposure horizon. An expected value criterion, thus assuming risk neutrality on the part of the decision-maker, is used. No attention is paid to the cash-flow cost of deriving an optimal temporal hedging path.

Managing Economic Exposure

As a general rule, economic exposure management should aim at neutralizing the impact of unexpected exchange rate changes on net cash flows; this will generally be achieved by striving for a balanced currency mix of cash flows between the cost and revenue side.

An operational approach for implementing this concept of economic exposure management was developed by Nauman-Etienne [54]: (1) identify managerial policies, operational characteristics, and environmental parameters to which economic exposure is sensitive; (2) define protective steps to minimize adverse effects of unexpected exchange rate changes on future cash flows.

Optimally, the sales-inputs currency mix should be adjusted so that changes in future sales revenue will be neutralized by changes in the cost of inputs; however, such changes in the real sector of the firm will seldom bring about by themselves a neutral economic exposure. Generally, manipulation of the currency risk of short-term and long-term financing will be needed and this is generally the easier to implement of the two prescriptions because the currency composition of financing can be altered independently from the sources of inputs and destination of sales; as such, it plays a natural residual and offsetting role in equating sales revenue and input costs on a currency-by-currency basis. Carrying this argument to its logical conclusion Dufey [16b] summarized it as "finance in the currency where your profits are." The obvious flaw in this approach is that it fails to incorporate the dynamics of the currency composition of cash flow which generally respond to a variety of exogenous factors which are difficult to anticipate. Also disregarded in these studies is the simultaneous and offsetting change in price levels; that is, the analysis is strictly conducted in nominal terms rather than in real terms.

The Praxis of Foreign Exchange Risk Management

Last but not least, exposure measurement and exposure management have to be coordinated and integrated within an internally consistent set of guidelines acceptable to both subsidiaries' and headquarters' treasurers. Foremost is the question of apportioning equitably the responsibility of Foreign Exchange Risk Management without distorting the control/evaluation process of foreign operations [Korth 42b]. Lessard and Lorange [43] address the dilemma faced by MNCs attempting to reconcile the organizational decentralization necessary for an ef-

fective planning/control system in a large multinational/multidivisional corporation and the centralization imperative which is at the core of effective Foreign Exchange Risk Management. Specifically, the authors consider the possible combination of exchange rates — to be used in (1) setting the operating budget for a particular time period and (2) tracking realized performance relative to budgeted ones. The authors suggest that the dilemma can be resolved through the use of "internal forward rates"; that is, rates which are guaranteed by the corporate treasury irrespective of what actual exchange rates may turn out to be.

Organizational and control considerations will undoubtedly play a crucial role in setting up such a Foreign Exchange Risk Management program which will generally have to be centralized at the helm of the corporate treasurer if the synergistic benefits of multinationalism are to be taken advantage of [Ankrom 4b]. This is indeed one of the major findings of a survey of corporate Foreign Exchange Risk Management practices by Jilling [40].

One unresolved question remains: How to insure a consistent attitude toward risk (both over time and across currencies) which wouldn't reflect exclusively the treasurer's preferences but which would be firmly grounded in senior management's outlook toward risk.

Long-Term Debt Financing

This review would not be complete without mentioning promising yet embryonic research efforts aimed at the determination of the optimal currency (or artificial currency unit) of denomination in long-term debt financing. Jacque [39a, chapter 8] develops a break-even analysis methodological framework based upon expected net present value formulae (thus implicitly assuming risk neutrality on the part of the decision-maker). Using a similar framework Giddy [30d] derives a number of simplifying formulae expressing the effective cost of foreign currency denominated debt financing as a function of its nominal cost. Both approaches fail to recognize the dependency (in a probability sense) of the vector of exchange rates to prevail when interest and principal repayment will be made. Thus, future exchange rates ought to be modelled as belonging to a joint multivariate probability distribution and necessary parameters of such variates be computed accordingly.

FOREIGN EXCHANGE RISK MANAGEMENT AND THE MARKET EFFICIENCY HYPOTHESIS

The emerging, yet embryonic, consensus among financial theoreticians is that exposure to foreign exchange risk may matter less than is commonly believed by multinational corporations' corporate treasurers, financial analysts, and investors. This jaundiced view of Foreign Exchange Risk Management is upheld by Logue and Oldfield [48] who argue that in efficient markets Foreign Exchange Risk Management is irrelevant and also relatively harmless. Theirs is loosely referred to as the Market Efficiency hypothesis and can be summarized in two propositions: in efficient capital markets, all available information is correctly impounded or reflected in stock prices. More specifically, investors are knowledgeable and sophisticated enough to be able to read beyond conventional accounting reports (balance sheets and income statements) to correctly assess the true economic value of the firm. This would mean, among other things, that hedging translation exposure to reduce or eliminate earnings variability is pure accounting gimmickry that shouldn't fool efficient investors.

Thus, in an efficient market, the multinational corporation's earning variability (resulting from translation gains or losses) would be placed in a proper economic perspective by investors and, therefore, should not affect its stock's price nor its cost of capital. However, such clearsightedness on the part of the market would require extensive and systematic disclosure by multinational corporations of their foreign subsidiaries' transaction, translation, and economic exposures.

This practice is clearly not yet accepted because multinational corporations generally disclose only consolidated financial statements.

This hypothesis seems to be contradicted in a recent empirical study by Makin [50a] which suggests (but doesn't necessarily prove) that, for instance, the first set of earnings reports prepared under FASB Statement No. 8 resulted for at least one group of firms (out of five) in the decline of their share prices that was not associated with overall market behavior. Thus the market would not be omniscient, and additional, albeit limited and imperfect, information (as that disclosed under FASB Statement No. 8) would lead investors to reevaluate their pricing of shares of corporations exposed to exchange risk. These preliminary results, however, failed to be upheld by the comprehensive study commissioned by the Financial Accounting Standards Board [Dukes, 18] which concluded that the issuance and implementation of FASB Statement No. 8 did not appear to have had significant detectable effects on the security returns of multinational firms.

Second, in efficient foreign exchange markets, currencies' prices adjust instantaneously to the inflation rates differential (Purchasing Power Parity hypothesis), thus leaving unchanged the true economic exposure to foreign exchange risk of a multinational corporation or of its foreign affiliates. The prescription in this case is simple: elaborate assessment of a firm's exposure to the inflation-cum-devaluation cycle is redundant and, a fortiori, managing economic exposure is about as irrelevant as managing accounting exposure. This point of view is elaborated upon by Aliber [3] and Giddy [30c].

Obviously, the operational value of such an extreme policy prescription will depend on the nature of the exchange rate system and the degree to which exchange rates reflect the relative internal purchasing power of any pair of currencies. Under a system of pegged yet adjustable exchange rates, par value adjustments may significantly lag price inflation differentials and the competitive position of the firm will be significantly and lastingly affected, thus calling for a strategic overhaul of the production and marketing policies. In the case of a domestic or an exporting company, an exchange rate adjustment that fails to reflect the true cost constraints of the sector in which the firm is operating will open new market horizons that would have been missed had the firm failed to recognize and/or anticipate correctly its true economic exposure.

Even in a world of floating exchange rates, which are being increasingly characterized as efficient, managing economic exposure may be a less dubious undertaking than implied by this second version of the Market Efficiency hypothesis. Instantaneous exchange rates adjustment to price levels differential will generally fail to capture the discrepancies among various sectorial price level movements that may indeed affect the true economic exposure of the firm. The sensitivity of the firm's cash flows to sectorial price movements should be carefully monitored and incorporated in marketing, production and financial plans. Even under strict conditions of foreign exchange market efficiency and positive bankruptcy costs, Dufey and Giddy [17] still prescribe that Management of Foreign Exchange Risk should aim at "structuring the firm's liabilities in such a way that any *unanticipated* change in the return on assets is offset, as far as possible, by a change in the effective cost of liabilities."

Nearly all normative research efforts in the area of foreign exchange risk management have focused exclusively on short-term decisions involving accounting exposure components of a firm's working capital and one may wonder why the case of stochastic transaction and translation exposures has altogether been ignored. Consider, for instance, the case of captive insurance companies which diversify their portfolio of underwriting activities by reinsuring a "layer" of foreign risk; clearly, the magnitude of the transaction exposure is unknown (stochastic).

FOREIGN EXCHANGE RISK MANAGEMENT: DIRECTIONS FOR FURTHER RESEARCH

Bidding on foreign projects or acquisitions of foreign companies will similarly entail stochastic exposures whose magnitude can be characterized at best by a subjective probability distribution. Similarly, hedging translation exposure always assumes that the translation exposure is known with certainty whereas, in fact, it is extracted from pro forma statements and, thus, should be considered as a random variable for Foreign Exchange Risk Managment purposes.

Furthermore, the longer-term dimension of Foreign Exchange Risk Management — that is, long-term debt financing and debt refunding in a multicurrency world — has hardly been considered.

In addition, most research undertakings — with two exceptions [Gull 35 and Makin 50b] — were limited to a two-currency world (foreign currency in which the exposure is incurred and reference currency [$] in which the MNC's financial statements are disclosed) thereby ignoring the diversification effect of holding a portfolio of exposures denominated in currencies whose prices are correlated.

Moreover, transaction and translation exposures were handled separately with no attempt at reconciling the two constructs into an operationally meaningful single aggregate index of real exposure to foreign exchange risk.

Finally, all decision models — with one exception [Shapiro and Rutenberg [69a] — were one-period models, thereby disregarding the sequential nature of Foreign Exchange Risk Management problems. The creation of new financial instruments such as interest rate futures, however, is opening new opportunities for research in this area as it provides information on future forward exchange rates — indeed a critical informational input for such decision models.

FOOTNOTES

1. Donald R. Lessard, *International Financial Management* (Boston: Warren, Gorhan and Lamont, 1979), p. 353.

2. For an analogous, but strictly qualitative four-step sequence see Korth [42a].

3. This concept of market efficiency should be clearly distinguished from the concept of market perfection. Market perfection is certainly a sufficient condition of market efficiency but it is not a necessary one. As long as transactors take into account all available information, even large transaction costs that inhibit the flow of transactions do not in themselves imply that when transactions do take place, exchange rates will not "fully reflect" all available information.

4. This three-tier categorization of Market Efficiency was suggested by Eugene Fama [23] for empirical testing purposes in the context of stock prices.

5. Failure to establish the weak form of Market Efficiency would lend credence to the Price Dynamics view of exchange rates behavior. One version of the Price Dynamics hypothesis (the so-called "bandwagon" theory) asserts that a subset of market participants (market leaders) are known or simply perceived by the rest of market participants (market followers) to have earlier access to more timely and more accurate information concerning factors affecting future spot exchange rates and/or to have the use of more sophisticated forecasting models. Thus when the price of a currency begins to fall (to rise) market followers will "jump on the bandwagon"; that is, join in the selling (buying) pressure as they attribute the price change to a signal that market leaders (who know better) have themselves begun to sell (to buy). In so doing, market followers will be pushing the currency price down (up) further until it overshoots its equilibrium level and the trend eventually reverses itself. Clearly this view of exchange rates behavior supports the hypothesis that past exchange rates contain useful information in forecasting future exchange rates as information only disseminates itself slowly among market participants, thus disproving the Market Efficiency hypothesis.

6. For a critical evaluation of testing methodologies see Kohlhagen [41a, pp. 32–34].

7. A dissenting and somewhat unconventional opinion is offered by Papadia [59] who challenges the view that the forward exchange rate is equal to the future spot exchange rate and argues that:

> one of the two currencies which is exchanged in a forward transaction is riskier than the other. This implies that the party buying forward the riskier currency will require a premium to enter the contract. Such a premium will necessarily be expressed as a difference between the forward and the expected spot rate. The two parties could agree on a future price and still enter the forward contract with a different one.

8. See for example Siegel's paradox [71] based on Jensen's inequality; McCulloch [52] suggests however that the bias introduced by looking at only one side of the market is negligible.

9. For an in depth discussion of the Modern Theory see Grubel [34] and Stoll [74].

10. Such an attitude toward risk by speculators would result into an infinitely elastic speculators' schedule.

11. An econometric model must contain a stochastic element to permit statistical inference from the data. The usual procedure is to hypothesize a model of varying degree of sophistication that should account for the phenomenon under review and then to add, almost as an after-thought, a disturbance or random error term to which convenient statistical properties are ascribed. This residual random error term represents in an undeterminate way all the factors that are ignored in the systematic part of the model.

12. Concerning the error term, e(t), the following six conditions for a correct use of multiregression analysis are all too often ignored: (1) $E[e(t)] = 0$, (2) $Var[e(t)]$ is constant and finite (homoscedasticity), (3) zero covariance between any two dependent variables (multicollinearity), (4) $Cov[e(t), e(t-k)] = 0$, (5) $Cov[e(t)$, dependent variable] = 0, and finally, (6) the error term is normally distributed $e(t) = N(0,s^2)$.

13. For a more limited attempt, see the model developed by Chemical Bank and discussed in Teck [75].

14. The concept of economic exposure is really the microeconomic analog of the well-known macroeconomic problem of balance of payments adjustment (or lack of) to changing exchange rates.

15. For reasons why the Interest Rate Parity theorem may fail to hold, see the comprehensive review monograph by Kohlhagen [41a], especially Section II. A primary explanation for observed deviations from Interest Rate Parity is transaction costs. For an attempt at measuring these costs, based on an ingenious device (trilateral arbitrage), see Levich [45b]. Levi [44a] shows that asymmetrical tax treatments of exchange capital gains/losses and interest income generally result in different after-tax Interest Rate Parity equilibria from the before-tax equilibria generally tested for in existing empirical work.

16. However no specific utility function model is used, which leaves the decision rules devoid of any operational content.

17. For a comprehensive discussion of artificial currency units, see Archeim and Park [5]. An empirical assessment of risk reduction provided by denominating contracts in artificial currency units is provided in Aubey and Cramer [6] as well as in Severn and Meinster [66] with the later study focusing exclusively on the use of SDRs.

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