1-1-1993

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August 1996

Abstract

The apparent persistence of unexploited opportunities for expected profits in foreign exchange markets suggests highly risk-averse market participants. Financial institutions put tight limits on the positions their foreign exchange dealers may have at risk at any time, despite beliefs that the odds are favorable that the positions will be profitable. This "safety first" practice is consistent with keeping the probability of ruin low enough to be of no practical concern. The setting of a very low probability of ruin for prudential reasons provides a rationale for traders behaving as if they have a degree of risk aversion that might otherwise seem implausibly high.

* I wish to thank Carol Osler and participants in seminars at City University London, Purdue University, Victoria University of Wellington and West Virginia University for helpful comments on earlier drafts without implicating them in any remaining shortcomings.

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1. Introduction

Observers of foreign exchange markets are sometimes puzzled by what they perceive to be extremely risk averse behavior. For example Goodhart (1988), in noting large forward discounts on foreign currency at times when there are no evident trends in the exchange rate, writes: "I have not ... seen any good explanations, i.e., ones that convince me, about what particular facets of risk may be responsible for such risk premia as seem inherent in the data." Empirical evidence by Dominquez and Frankel (1993) also suggests extremely large coefficients of risk aversion in foreign exchange markets.

In addition, banks, which do a substantial amount of dealing in foreign exchange markets and which presumably have the best information about likely short-term movements in exchange rates, place tight limits on their overnight positions even when those positions are expected to yield substantial profits. To paraphrase Goodhart, what facets of risk are responsible for such highly risk-averse behavior?

I propose that the idea of gambler's ruin provides a key facet of risk that can help us make sense of estimates of risk aversion that may otherwise seem implausibly large. It also helps us understand the tendency of large traders to view risk primarily as downside risk, as in "what is the worst that can happen?"

In what follows, Section 2 discusses two well established properties of foreign exchange markets that, as Goodhart points out, imply the existence of persistent risk premia. This sets the stage for thinking in terms of odds of success in speculative positions. The forward discount, in fact, can be used to calculate illustrative odds for success.

A popular form of utility function with a constant coefficient of relative risk aversion is used to Section 3 to have explicit relationships between odds, positions and implied coefficients of risk aversion. A pervasive problem with this construct, however, is what to make of a particular estimate of the coefficient of risk aversion. I for one have no idea what my coefficient is nor little idea what determines how large it should be.

It is likewise dubious that foreign exchange speculators think in terms of a coefficient of risk aversion in deciding on their positions. Their practice of limiting how much is "at risk" is more closely related to the concept of "safety first" suggested by Roy (1952) and discussed in Section 4.

A particular form of safety first is to design procedures that will make the probability of ruin sufficiently small that it is of no practical concern. Probability of ruin refers to the classical gambler's ruin problem in probability theory, introduced in Section 5. Section 6 analyzes the linkage between probabilities of ruin and the coefficient of relative risk aversion. Section 7 concludes.

2. Currency Risk Premia

Goodhart's expresses concerns about the compatibility of two well-established relationships in foreign exchange markets:

(a) Covered interest parity holds.

(b) Exchange rates follow approximately a martingale process.

These give rise to what appear to be persistent unexploited profit opportunities.

Covered interest parity, which states that the forward premium on the price of a foreign currency equals the difference between the domestic and the foreign interest rate, can be written as the following relationship:

(1) $$f_{t,n} - s_t = r_{t,n} - r_{t,n}^*$$

where s_t is the spot exchange rate, measured as the log of the domestic price of foreign currency, $f_{t,n}$ is the forward rate, measured as the log of the price of foreign currency agreed to at time t for purchase at time t+n, $r_{t,n}$ is the log of one plus the domestic interest rate for a loan at time t that matures at time t+n, and $r_{t,n}^*$ is the log of one plus the corresponding foreign interest rate. Arbitrage opportunities when (1) does not hold assure that any departures from an exact equality will be limited by transactions costs. Covered interest parity has been well documented empirically.

The property that a foreign exchange rate follows a martingale process amounts to saying that the expected value at time t of what the spot exchange rate will be at time t+n equals the spot exchange rate at time t. Formally:

(2) $$E_t s_{t+n} = s_t$$

Recent evidence suggests that (2) may not hold precisely but there is little doubt that it is good approximation. Bilson (1985), for example, has referred to equation (2) as an "empirical paradigm." Foreign exchange markets are interconnected webs of market makers, customers, brokers and speculators, often in different parts of the world. At the centers of these webs are market makers who stand ready to quote a two-way price to customers and other market participants. Quotes are adjusted whenever new information reaches the market. More specifically, Lyons (1993) presents evidence that a market maker adjusts prices in response to quantities traded, to whether incoming orders are buy or sell orders, and to inventory positions.

Suppose a market maker receives a large order to buy pounds with dollars. There is a choice of waiting for someone to sell pounds at the lower bid price or of replenishing inventory by buying pounds from another market participant. The market maker, when sensing that at the current price there will be more buy orders of pounds before sell orders arrive, will try to restore her own inventory, as Burnham (1991, p. 135) writes, "by going to another marketmaker or broker market for a two-way price. A game of 'hot potato' has begun. ... It is this search process for a counterparty who is willing to accept the new currency position that accounts for a good deal of the volume in the foreign exchange market."

The search process with a "hot potato" also suggests why exchange-rate movements appear to be like a martingale. As traders become aware of the activity by other traders on one side of the market, such as the attempts to buy pounds, they shade up their dollar/pound bid and ask prices. Market makers, with inventories at desired levels, will try to adjust their current quotes so that the next outside order is equally likely to be a buy or sell order. The next price movement is thereby equally likely to be an increase or a decrease. The general perception is that the martingale property is a reasonable way to describe exchange-rate movements but, as indicated below, many market participants do not consider it literally true.

Equations (1) and (2) imply that whenever interest rates differ in two countries, the forward rate does not equal the expected future spot rate. Suppose for example that the foreign interest rate exceeds the domestic interest rate ($r_{t,n}^* > r_{t,n}$). This means that the forward rate is below the spot rate ($f_{t,n} < s_t$) or that the foreign currency is selling at a discount on the forward market. Therefore by (2) the forward rate is below the expected spot rate ($f_{t,n} < E_t s_{t+n}$). This is illustrated in Figure 1. At time t, a density function $g(s_{t+n})$ shows the possible outcomes for the spot exchange at time t+n. With $E_t s_{t+n} = s_t$ to the right of the forward rate $f_{t,n}$, an incentive seemingly exists to buy the foreign currency forward.

Froot and Thaler (1990) and Taylor (1995) discuss substantial evidence of an even more anomalous pattern. When the change in the spot exchange rate is regressed on the forward discount as in

$$(3) \qquad s_{t+n} - s_t = \alpha + \beta (f_{t,n} - s_t) + u_t$$

the estimates of β have been predominately negative over relatively short horizons and with moderate differences in interest rates. Thus, if foreign interest rates rise so that the foreign currency is selling at a discount, these regression results (if believed) would call for an expected appreciation of the foreign currency. This should add to the incentive to buy foreign currency forward when it is selling at a discount or to create a synthetic forward purchase by reducing domestic holdings, buying foreign currency in the spot market and increasing foreign holdings, thereby expecting to earn an excess return over and above the interest differential on the higher yielding foreign asset.

The difference between the expected spot rate and the forward rate is known as the "risk premium," and there are differences of opinion about what determines the size of this premium. Suppose interest rates are 7 percent in both the US and the UK. The forward premium is zero and if the expected change in the dollar/pound exchange rate is also zero, then the risk premium is zero. Now suppose for some reason that interest rates fall to 5 percent in the US while at the same time interest rates rise to 9 percent in the UK. Whatever the immediate adjustment of the spot exchange rate between dollars and pounds as a result of these changes, the future spot rate in the very short run may still be expected on average to equal the new spot rate as soon as market makers have adjusted their bid-ask quotes. In this example, the risk premium has risen to 4 percent.

One possible interpretation of this change is that international investors on balance suddenly view the pound as the riskier currency. In their attempt to get out of pound assets and into dollar assets, they sell UK and buy US treasury bills. This has the effect of raising UK and lowering US interest rates. Since such movements in interest-rate differentials, between countries with convertible currencies, are usually not accompanied by news that one currency has become much riskier to hold, it strains credulity to think that changing views of risk are driving changes in the forward-spot spread and hence, by covered interest parity, changes in the interest-rate differences between countries. Meese (1989, p. 171) in a review of empirical research reports: "While it appears that current econometric techniques are sufficiently powerful to reject the unbiased forward rate hypothesis at very small significance levels, attempts to empirically characterize exchange market risk premiums have met with only limited success."[1] More recently, Isard (1995, p. 142) has written, "... the forward rate unbiasedness hypothesis is strongly rejected for reasons that economists do not yet fully understand ..."

An alternative view, espoused by Goodhart (1988), is that interest-rate differentials create risk premia, rather than the reverse, and because of the risk-averseness of speculators a premium persists until domestic forces change the interest-rate differential. In the foregoing example, US interest rates could have fallen because of an easier monetary policy in the US and risen in the UK because of a tighter monetary policy there, and speculation was not strong enough to keep the interest differential and a risk premium from developing. Bilson (1981) expresses a similar view when testing the hypothesis that the forward premium is an unbiased forecast of the future spot rate: "An [extreme] alternative hypothesis is that the forward premium is purely determined by nonspeculative factors and is consequently unrelated to the future rate of depreciation. ...the extreme alternative is more consistent with the sample data than the speculative efficiency hypothesis."

Before proposing an answer to the question about what facets of risk are responsible for the risk premia inherent in foreign exchange markets, I turn first to a discussion of "risk aversion" as usually interpreted.

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[1] Similar concerns are expressed by Mankiw and Summers (1984) about a "liquidity premium" in the term structure of interest rates. They comment that the expectations theory of the term structure "becomes almost vacuous" when it is extended to include a time-varying liquidity premium. "Without an explicit theory of why there is such a premium and why it varies, it has no function but tautologically to rescue the theory" (p. 239).

3. Risk Aversion

When one economist uses the term "risk aversion," most other economists have a good idea of the intended meaning. The degree of risk aversion usually refers to a measure of the concavity of a utility function of the sort developed by Von Neumann and Morgenstern (1947). A popular formulation is to specify a utility function that represents what is known as constant relative risk aversion (CRRA). This can be written:

$$(4) \qquad \begin{aligned} U(w) &= [w^{(1-r)}]/(1-r) \qquad && r > 0, r \neq 1 \\ &= \log w && r = 1 \end{aligned}$$

where w = wealth (or funds available), and r = the coefficient of relative risk aversion.

As an example of how much of a favorable gamble a risk averse person will take, suppose agents are confronted with the following possibility. They can participate in a bet and either win x with probability p or lose x with probability 1-p. If the odds are in their favor (p > .5), the size of a bet that a risk-averse person with this utility function will undertake can be determined by choosing x to maximize expected utility:

$$p\, U(w+x) + (1-p)\, U(w-x).$$

The solution with the CRRA utility function is to choose

$$(5) \qquad w/x = [1 + q^{1/r}]/[1 - q^{1/r}]$$

where q = (1-p)/p.

In this case, if p = .51 and r = 3, then equation (5) calls for the individual to risk two thirds of one percent of available wealth (w/x = 150). Does a coefficient of 2 or 3 represent a high degree of risk aversion?[2] Estimates that come from data on foreign

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[2] See, for example, Newberry and Stiglitz (1981), Hansen and Singleton (1983), and Mehra and Prescott (1985) for a variety of estimates in other contexts.

exchange markets suggest coefficients dramatically higher. Dominguez and Frankel (1993) estimate the effects of central bank intervention on the risk premium. As a byproduct of their specification, one of their coefficients can be interpreted as the coefficient of relative risk aversion (CRRA). Their CRRA estimates that are significant at the one percent level range from 165 to 656! While such estimates may seem to be implausibly high, an understanding of risk management practices in foreign exchange markets may help to put these estimates into perspective.

4. Foreign Exchange Value at Risk and Safety First

Central banks are naturally concerned about the solvency of banks under their jurisdiction. When it comes to the extent of a bank's foreign exchange exposure, the central bank often offers guidelines on upper limits for open positions. For example, the Bank of England (1981) suggests that banks limit their overnight positions in all currencies to 15 percent of capital and in any one currency to 10 percent of capital. The banks themselves often impose even smaller limits and in practice keep their open positions well below their own limits much of the time. According to Goodhart (1988), "the size of banks' open positions is quite a small, often a very small, proportion of their capital."

In addition, when banks leave a position open overnight, they place stop-loss orders on those positions. A New York bank might take a long overnight position in Deutsche marks in anticipation of a rise in the price. If, contrary to expectations, the price of the mark falls by enough, the bank's standing order will be executed to close out the position once the loss has reached a predetermined amount.

Regulatory agencies are now urging that dealers report "value at risk" in their portfolios. See Hendricks (1996) and Hopper (1996) and references cited by those authors. Value at risk is a measure of the largest loss that can be expected over a specified period no more than a small fraction of the time. This requires estimates of the distribution of changes in a portfolio's value over say 20 days. A one percent value at risk would report the loss that would be exceeded no more than one percent of the time. As Hendricks writes "value-at-risk measures focus directly ... on a major reason for assessing risk in the first place -- a loss of portfolio value."

Boudoukh, Richardson and Whitelaw (1995) suggest that an alternative or complementary "worst-case scenario" may be even more appropriate. They ask "what is the worst that can happen to the value of the firm's trading portfolio over a given period (e.g., 20 trading days)?" In effect they recommend assessing how big that loss is likely to be that occurs one percent of the time.

This worst-case scenario is very much in line with the way that banks which deal in foreign exchange define risk. Open positions are "at risk" to the extent of losses that can occur before the position is closed. If the New York bank holds $20 million worth of marks at the close of its business day and places a one percent stop-loss order, then a one-percent fall in the price of the mark from its close in New York will mean that the New York bank will lose $200,000. Consequently, the bank has $200,000 at risk in its mark position. My own interviews with several dealing room managers indicate that defining "at-risk" in terms of how much can be lost is common practice among those concerned with risk management of foreign exchange positions.

Dealers take open overnight positions because the information they have about the market or possible announcements that may occur leads to a belief about the likely direction of movement in particular currencies. According to The Foreign Exchange Manual: "It should be possible to say, for example, that the accumulated profits on good deals and positions will always give 150 percent cover for wrong deals and positions (the 60:40 success relationship)".[3] Dacorogna, et al. (1992), utilizing continuous monitoring

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[3] Some managers claim that their traders are right 60 to 70 percent of the time but were unwilling to reveal to an outsider any evidence of their success ratio in positions taken.

of bid and ask prices, report out-of-sample forecasts of exchange rate movements that are generally right well over 50 percent of the time 2, 4 and 8 hours ahead. And, as indicated below, interest rate differences between countries of 4 percent per year suggest a 53 percent probability that the spot rate in one month will exceed the one month forward rate.

In the face of what are perceived to be favorable odds, large players in the foreign exchange markets choose to limit the amount at risk at any one time. Consequently, they are also limiting their expected earnings from foreign exchange dealing. This behavior is reminiscent of Roy's principal of Safety First. Roy (1952) wrote that "the principle of Safety First asserts that it is reasonable, and probable in practice, that an individual will seek to reduce as far as is possible the chance of a catastrophe occurring" (p 432).[4]

Telser (1955) introduces a probabilistic interpretation of safety first. He assumes that for each action **a** there is a probability distribution of net income I. Any level of net income below R he terms a “disaster”. Telser postulates that an entrepreneur will consider admissible only those actions that satisfy the condition that $\Pr[I \leq R; \mathbf{a}] < \alpha$. In other words, given a critical probability α, only those actions will be considered for which the probability of a disaster is less than or equal to α. In terms of bank's open positions, R can be interpreted as losing the amount that it has at risk.[5]

A question naturally arises why might those setting limits on foreign exchange positions want to think in those terms. One reason for limiting positions despite favorable odds may be found in the concept of gambler's ruin from probability theory. As shown in the next section, this also provides an analytical link between bank's

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[4] Roy also commented: "A man who seeks advice about his actions will not be grateful for the suggestion that he maximise expected utility."

[5] In setting position limits on individual currencies, risk managers in many banks also consider a covariance analysis across currencies in assessing what is at risk for the dealing room as a whole.

operating procedures and the extremely high coefficients of risk aversion that appear to pervade the foreign exchange markets.

5. Gambler's Ruin

The idea of the classical ruin problem is to imagine two people undertaking a series of independent bets until one or the other has lost everything. Feller (1950) provides an explicit solution to the problem of determining the probability that a particular one of the gamblers is the eventual loser. Let z be the stake of one gambler and y be the stake of the other gambler. If each bet is 1 unit, then Feller (pp. 283-4) shows that the probability that the first gambler is ruined (loses z) can be represented by the following formulas:

$$\text{(6)} \quad \begin{aligned} \Pr[\text{ruin}] &= [q^{y+z} - q^{z}]/[q^{y+z} - 1] \qquad & 0 < p < 1, p \neq .5 \\ &= y/(y+z) \qquad & p = .5 \end{aligned}$$

where as before $q = (1-p)/p$ and p is the probability of winning each single bet.

Now think of the first gambler as placing bets against a "house." Note that, when the odds are unfavorable and one is determined to gamble anyway, the greatest probability of winning the target amount and the smallest probability of losing one's stake is to bet everything at once. With unfavorable odds, smaller bets increase the chance of losing an entire stake. On the other side of these bets, however, the house prefers small bets relative to its stake. With the odds in its favor, the house can expect a good regular income with virtually no chance of going bankrupt, although it may also put a minimum on the size of the bets in order to speed up the process of collecting its expected winnings.

To put Feller's solution into the context of a foreign-currency speculator trying to decide how much to risk on a specific opportunity and to relate that to decisions by someone with an assumed risk-averse utility function, imagine the foreign exchange dealer as running a casino and the odds are in the dealer's favor because of information about likely exchange rate movements. While the other side of these positions might be taken by transient traders who are ruined by unfortunate losses, the bulk of those who in effect have the odds against them are what might be called liquidity traders, the importers and exporters of goods and capital. The dealer may buy foreign currency from an exporter and then sell the same currency to an importer. If the price rises between these transactions, the dealer makes money both on the bid-ask spread and on the rise in price. Neither the exporter nor the importer has lost, except perhaps in an opportunity cost sense if their transactions might have been timed differently, but they represent a conglomerate player who provides profitable opportunities to knowledgeable dealers.[6]

As in the example with the CRRA utility function, let w denote a bank's available wealth or capital, p (> .5) the probability of winning x, and 1-p the probability of losing x. Let z = w/x and think of z as the stake in units of bets. The foreign-currency dealer with a wealth w, confronted with a series of opportunities to win or lose an equal amount, makes a decision about the amount x to risk on each opportunity. The dealer will be assumed to consume any gains, so as soon as x has been won it is consumed and the game is repeated. Ruin occurs if the dealer loses w before winning x. Under those circumstances, equation (6) can be rewritten as:

$$\text{(7)}\quad \begin{aligned} \Pr[\text{ruin}] &= [q^{1+w/x} - q^{w/x}]/[q^{1+w/x} - 1] && 0 < p < 1,\ p \neq .5 \\ &= 1/(1+w/x) && p = .5 \end{aligned}$$

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6 Bilson (1981) estimates a forecasting model using the forward premium and finds that cumulative expected profits in a post sample period were 46.5 standard deviations above zero over 50 periods. "If the speculator knew that the forecasting model was correct, then the risk from speculation is small. The situation is exactly akin to that of a casino operating a roulette wheel." (p. 446)

Like the owners of a casino, the successful currency traders or those who back them have little intention of going bankrupt. They want to limit the size of their speculative positions in foreign exchange markets to a small fraction of their stake so that the probability of ruin is sufficiently small.[7]

To introduce numerical examples based on uncovered interest rate differentials, suppose interest rates in two countries differ by 4 percent per year. Then a one-month forward rate, as depicted for example in Figure 1, would be somewhat more than .3 percent below the spot rate. The standard deviation of monthly changes in major exchange rates is about 3.6 percent.[8] So, with a 4 percent difference in annual interest rates, the one-month forward rate is at least .083 standard deviations below the spot rate. The probability of a standard normal variable being above -.083 is 53 percent. Thus the odds of a favorable outcome from taking a forward position when annual interest rates differ by 4 percent are 53 to 47, the same as the odds against a bettor betting on black on a roulette wheel when the house has a 2/38 chance that the ball will stop on neither red nor black. Of course with smaller interest differentials the odds become smaller.

Table 1 provides numerical examples from equation (7) of tradeoffs between positions taken, odds for success, and probabilities of ruin. If the probability of success on each trial is .51 and each bet risks 1/150 of original wealth, then as shown on line 1 the probability of ruin is .01 percent. Lines 3 and 5 show that, as the odds become more favorable, a larger fraction of wealth can be bet each trial and still have the same probability of ruin.

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[7] Some of the recent cases of huge losses from speculation by Barings, Daiwa and Sumitomo banks appear to have arisen not so much from a willingness by management to incur high risk but rather because of inadequate supervision of the record keeping of the traders taking risky positions.

[8] A sample of month-to-month changes in the DM, Pound and Yen against the dollar from 1977:09 to 1990:07 had average standard deviations of 3.56, 3.55 and 3.69 percent respectively.

The actual expected payoffs from taking open positions in foreign exchange markets depend on the strategies employed, such as the circumstances under which positions will be closed, but suppose it were possible to design a strategy in which speculators earn one percent of their position with a probability of .53 and lose one percent with a probability of .47. For some currencies a move of plus or minus one percent represents plus or minus two standard deviations of daily changes. In this example of winning or losing one percent, a position of 100 percent of capital puts at risk one percent. That would be equivalent to $w/x = 100$. If the odds for success on each trial is 53 to 47, as shown on line 6 of Table 1, the probability of ruin is 6.86×10^{-7}.

Recall the Bank of England guideline of limiting open positions to 10 percent of capital in any one foreign currency. Once again if one percent of a position is at risk, then this guideline would imply $w/x = 1000$. Lines 2, 4, 7 and 8 show that probabilities of ruin are very small. Since most banks keep well below those guidelines unless an unusually promising situation arises, the probability of ruin becomes truly negligible.

6. Linking Gambler's Ruin to Risk Aversion

While the discussion has been couched in terms of currency speculation, an important point here is to draw attention to the linkage between the probability of ruin and a coefficient of risk aversion. The last column of Table 1 shows the coefficient of relative risk aversion that will call for the position w/x given the probability p. As noted earlier, when the odds are 51 to 49, the speculator who limits bets to 1/150 of available wealth would, according to equation (5), have a coefficient of relative risk aversion of 3.

If $p = .53$ and a bank puts at risk as much as 1/1000 of its capital, then the coefficient of relative risk average is over 60. If banks put less at risk for the same p or they put the same amount at risk with a higher p, the implied coefficient of risk aversion will be even higher. In this light, the statistically significant estimates of CRRA reported by Domiquez and Frankel (1993) no longer seem quite so implausible.

For given odds, there is a one-to-one mapping from the maximum acceptable probability of ruin to the degree of relative risk aversion, because the ratio of w to x increases monotonically as either the probability of ruin falls or the coefficient of relative risk aversion rises. Analytically, with CRRA, substitution of w/x from equation (5) into (7) gives a function relating r to Pr[ruin]. Thus, a maximum acceptable probability of ruin implied by positions and odds has a corresponding CRRA.

While there is a one-to-one relationship between the probability of ruin and a coefficient of relative risk aversion for given odds of success on each position taken, they are not fully interchangeable concepts as the odds change. This can be seen by considering the three entries in Table 1 for which Pr[ruin] = .0001. Each of the three (lines 1, 3 and 5) implies a different value for r. Thus, an individual who chooses speculative positions on the basis of a maximum probability of ruin will exhibit different degrees of risk aversion depending on the odds. This is contrary to the typical assumption in the literature that an individual has a specific utility function that guides choices under uncertainty no matter what speculative opportunities are available. In the cases in the table, the more favorable the odds the more risk averse the same individual will appear to be if speculative positions are dictated by a particular maximum probability of ruin.

Once transactions costs are taken into account, favorable odds of 53 to 47 may not be all that attractive. If there is a gain of one percent with a probability of .53 and loss of one percent with a probability of .47, the expected gain is .06 percent. With bid-ask spreads on major currencies in the range of .03 to .06 percent, there is little leeway for net gains for speculators who buy at ask prices and sell at bid prices. For similar reasons, moderate departures from uncovered interest parity are unlikely to stimulate much speculative activity.[9]

Open positions by market makers are not subject to the same transactions costs. Given their bid-ask quotes their open positions arise because of a balance of orders received on one side of the market. If a dealer has had a run of purchases of foreign exchange at his ask price, he presumably could close his position at roughly the same ask price from another dealer. If he expects a drop in price, he might wait to square his book. Most of these positions are closed overnight. Any such positions left open because of anticipated price movements are subject to the prudential limits discussed earlier and will have stop-loss orders limiting the amount at risk.

Banks that have a strong customer base do not think literally of letting foreign exchange operations bankrupt them even with a tiny probability of a disasterous run of unfortunate moves against their positions. The calculations of probabilities of ruin were predicated on continuing to put at risk the same amount all the time. Actual procedures are such that the at-risk amounts are at most a set fraction of capital, so smaller capital means less at risk. And if a bank cannot operate profitably in foreign exchange markets, it will drop out of the market.[10]

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[9] Goodhart and Taylor (1992) use a utility specification and note institutional restrictions on minimum positions in the currency futures markets to argue that ordinary wealth holders would find taking such minimum positions "too dangerous."

[10] After the New Zealand dollar started floating, 21 banks in New Zealand made a market in the NZ$ in 1985. By 1993, only 7 of these banks were still making a market in their own currency.

7. Conclusion

Banks' actual procedures in setting position limits are evidently guided by Roy's principle of Safety First. They determine the overnight limits in terms of how much is "at risk," i.e., what is the most that can be lost with an adverse move in exchange rates. No dealing room manager thinks in terms of a degree of risk aversion in the way economists typically do.

Persistence of risk premia and other evidence of risk averse behavior in foreign exchange markets can arise because of procedures that limit the amount that speculators put at risk at any time. A reason for such limits can be found in the theory of gambler's ruin. Speculators, who have a good knowledge of the market so that the odds are in their favor when they take positions, can make the probability of ruin sufficiently small to be of no consequence by imposing these limits on themselves. They therefore forego expected profits for prudential reasons.

Given the odds, there is a mapping between the probability of ruin and a coefficient of relative risk aversion. While the assumption of a risk-averse utility function guiding the choice to limit positions is not fully equivalent to setting a maximum acceptable probability of ruin, procedures to avoid potential ruin can clearly give rise to what economists consider to be unusually risk-averse behavior.

References

Bank of England, "Foreign Currency Exposure," April 1981.

Bilson, John F. O., "The 'Speculative Efficiency' Hypothesis," Journal of Business, 54, July 1981, 435-451.

Boudoukh, Jacob, Matthew Rischardson and Robert Whitelaw, "Expect the Worst," Risk, 8 (September 1995), 100-101.

Bilson, John F. O., "Macroeconomic Stability and Flexible Exchange Rates," American Economic Review, 75 (May 1985), 62-67.

Burnham, James B. (1991), "Current Structure and Recent Developments in Foreign Exchange Markets," in Recent Developments in International Banking and Finance, Volume IV, S. J. Khoury, ed., Elsevier North Holland, 123-153.

Coninx, Raymond G. F., Foreign Exchange Dealer's Handbook, (2nd ed.) Cambridge: Woodhead-Faulkner, 1986.

Dacorogna, M.M., C.L. Gauvreau, U.A. Müller, R.B. Olsen, and O.V. Pictet, "Short Term Forecasting Models of Foreign Exchange Rates," Olsen and Associates, July 10, 1992.

Dominguez, Kathryn M. and Jeffrey A. Frankel, "Does Foreign-Exchange Intervention Matter? The Portfolio Effect," American Economic Review, (December 1993), 1356-69.

Feller, William, An Introduction to Probability Theory and Its Applications, John Wiley & Sons, 1950.

Froot, Kenneth A. and Richard H. Thaler, "Anomalies: Foreign Exchange," Journal of Economic Perspectives, 4 (Summer 1990), 179-192.

Goodhart, Charles, "The Foreign Exchange Market: A Random Walk with a Dragging Anchor," Economica, 55, November 1988, 437-60.

Goodhart, C. and M. Taylor, "Why Don't Individuals Speculate in the Forward Foreign Exchange Market?" Scottish Journal of Political Economy, 39, February 1992, 1-13.

Hansen, Lars Peter and Kenneth J. Singleton, "Stochastic Consumption, Risk Aversion, and the Temporal Behavior of Asset Returns," Journal of Political Economy, 91 (April 1983), 249-265.

Hendricks, Darryll, "Evaluation of Value-at-Risk Models Using Historical Data," Economic Policy Review, Federal Reserve Bank of New York, April 1996, 39-69.

Hopper, Gregory P., "Value at Risk: A New Methodology For Measuring Portfolio Risk," Business Review, Federal Reserve Bank of Philadelphia, July/August 1996, 19-31.

Hsieh, David A., "The Statistical Properties of Daily Foreign Exchange Rates: 1974-1983," Journal of International Economics, 24, February 1988, 129-145.

Isard, Peter, Exchange Rate Economics, Cambridge University Press, 1995.

Lyons, Richard K., "Tests of Microstructural Hypotheses in the Foreign Exchange Market," Journal of Financial Economics, 39 (October 1995), 321-351.

Mankiw, N. Gregory and Lawrence H. Summers, "Do Long Term Interest Rates Overreact to Short-Term Interest Rates?" Brookings Papers on Economic Activity, 1984: 1, 223-242.

Meese, Richard, "Empirical Assessment of Foreign Currency Risk Premiums," in Courtenay C. Stone (ed.), Financial Risk: Theory, Evidence and Implications, Kluwer Academic Publishers, 1989,157-180.

Mehra, Rajnish and Edward Prescott, "The Equity Premium: A Puzzle," Journal of Monetary Economics, 15, March 1985, 145-162.

Newberry D. and J. Stiglitz, The Theory of Commodity Price Stabilization: A Study in the Economics of Risk, John Wiley, 1981.

Roy, A. D., "Safety First and the Holding of Assets," Econometrica 20 (July 1952), 431-49.

Telser, Lester G., "Safety First and Hedging," Review of Economic Studies, 23 (January 1955), 1-16.

Von Neumann, J. and O. Morgenstern, Theory of Games and Economic Behavior, second ed., Princeton University Press, 1947.

Weisweiller, Rudi (ed.), The Foreign Exchange Manual, Woodhead-Faulkner, 1992.

Table 1

Illustrative Probabilities of Ruin and CRRA

	p	w/x	Pr[ruin]	r
1	.51	149	.0001	3.0
2	.51	1000	1.66×10^{-19}	20.0
3	.52	83	.0001	3.3
4	.52	1000	1.33×10^{-36}	40.0
5	.53	58	.0001	3.5
6	.53	100	6.86×10^{-7}	6.0
7	.53	1000	7.51×10^{-54}	60.1
8	.54	1000	3.43×10^{-71}	80.2

p = probability of winning each bet
w = initial wealth
x = size of each bet
Pr[ruin] = probability of ruin
r = coefficient of relative risk aversion (CRRA)

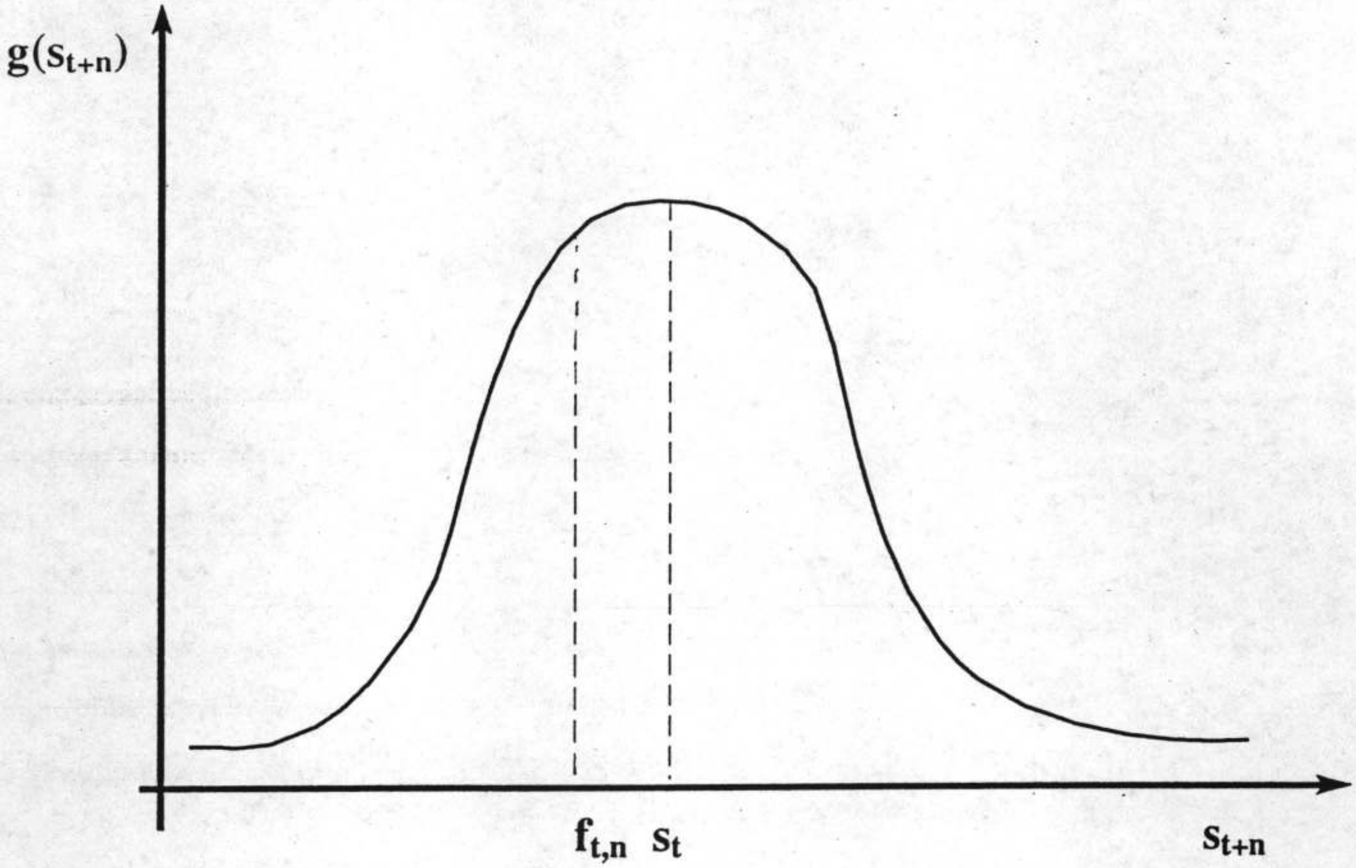

Figure 1

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1993. Journal of International Business Studies, 24: 693-714.

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