NBER WORKING PAPER SERIES

# ANALYZING THE ACCURACY OF FOREIGN EXCHANGE ADVISORY SERVICES: THEORY AND EVIDENCE

Richard M. Levich

Working Paper No. 336

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge MA 02138

April 1979

I wish to thank the many kind people who supplied, or are still planning to supply, their forecast data. Helpful discussions with A. Brillembourg, C. Ramond, and B. Smith are gratefully acknowledged. Any remaining errors are my own.

The research reported here is part of the NBER's research program in International Studies. Any opinions expressed are those of the author and not those of the National Bureau of Economic Research.

NBER Working Paper 336
April 1979

# Analyzing the Accuracy of Foreign Exchange Advisory Services: Theory and Evidence

SUMMARY

With the introduction of floating exchange rates, the variability of unanticipated exchange rate changes has increased dramatically. A small forecasting industry has developed to provide information about future exchange rates. From an academic viewpoint, it is of interest to examine some of the statistical properties of these forecasts and to relate the forecast errors to other fundamental economic variables in a model with rational behavior. Second, from a more practical viewpoint, we would like to know if foreign exchange forecasts are useful to decision makers.

The purpose of this paper is to provide an objective analysis which addresses some of the above questions for a large sample of forecasts. On the basis of the current research, we can draw several conclusions. First, most advisory service forecasts are not as accurate as the forward rate in terms of mean squared error. Second, judgmental forecasters are superior to econometric forecasters for short-term forecasts; the relationship is reversed for longer-term forecasts (one year). Third, two statistical tests indicate that the fraction of "correct" forecasts is significantly larger than what would be expected if the advisory services were only guessing at the direction of the future spot rate. In this sense, the forecast services appear to demonstrate expertise and usefulness. However, a full analysis of the risk-return opportunities available to advisory service users is still incomplete.

It should be cautioned that if the forward rate contains a risk premium, then we expect advisory service models to beat the forward rate according to the tests we have outlined. In this case we must measure speculative returns relative to a risk measure. While advisory service forecasts may lead to profits, they may not be unusual after adjusting for risk.

Richard M. Levich
New York University
Graduate School of Business
100 Trinity Place
New York, N.Y. 10006
(212) 285-6176

## I. Introduction

With the introduction of floating exchange rates in the early 1970's, the statistical variability of exchange rates increased dramatically. These exchange rate changes were not perfectly anticipated. Hence, the variability of unanticipated exchange rate changes also increased. The more than five year history of floating exchange rates has seen periods of both relative calm and turbulence. In particular, during the last year unanticipated exchange rate changes increased to unprecidented high levels for many currencies (Levich 1978). In this setting it is obvious that firms and investors could have enjoyed higher earnings if they had more timely and accurate information about future exchange rates. [1]

In the present floating rate period, accurate information about future exchange rates appears to be a scarce resource and, correspondingly, it has a high value. A small exchange rate forecasting industry has developed. [2] In general, these firms sell information about future exchange rates. Their specific methodology and products cover a wide range of possibilities. Some firms rely on a strictly qualitative approach; others are highly technical, utilizing simultaneous equation models, spectral analysis, or catastrophe theory. The output from these models may be a point estimate of the future spot rate, the quarterly average for some future period, or possibly just the future trend movement.

Forecasts play two important roles in economic analysis. First, the ability to predict the consequences of changes in underlying circumstances is an important part of economics as

a positive science. Analysis of economic forecasts is an essential diagnostic check of the adequacy of a theory or model. [3] Second, economic decisions on consumption and investment depend on information, which includes predictions of future events. Since the future value of economic variables may be (currently) unobservable, economic agents must rely on forecasts.

The motivation for this paper is to examine hypotheses based on these two roles. [4] First, from an academic viewpoint, it is of interest to examine the adequacy of foreign exchange forecasting models. Specifically,we would like to determine (1) How accurate are professional forecasters, (2) Do forecasters produce rational, unbiased forecasts, (3) Do forecasters revise their predictions so that their forecast errors are serially uncorrelated, (4) What fundamental factors are associated with forecast errors, and (5) What determines the heterogeneity of forecasts across advisory services. Second, from a more practical viewpoint, we would like to know if foreign exchange forecasts are useful to decision makers. Specifically, we would like to examine (1) If the predictions of advisory services are more accurate than the forward rate, (2) How the accuracy of prediction varies across currency, forecasting horizon, and time period as well as forecasting service and (3) Whether the predictions of any forecasting service would have resulted in unusual speculative profits. These two motivations are, of course, highly complementary.

The purpose of this paper is to provide an objective analysis which addresses some of the above questions for a large sample of forecasts. On the basis of the current research, we can draw several conclusions. First, most advisory service forecasts are not as accurate as the forward rate in terms of mean squared error. Second, judgmental forecasters are superior to econometric forecasters for short-term forecasts; the relationship is reversed for longer-term forecasts (one year). Third, two statistical tests indicate that the fraction of "correct" forecasts is significantly larger than what would be expected if the advisory services were only guessing at the direction of the future spot rate. In this sense, the forecast services appear to demonstrate expertise and usefulness. However, a full analysis of the risk-return opportunities available to advisory service users is still incomplete.

The paper continues in section II, where we present a theoretical discussion of the conditions under which foreign exchange forecasts are likely to convey valuable information. In section III we discuss alternative techniques for evaluating forecasts. The empirical analysis of recent exchange rate forecasts is presented in section IV.

## II. The Value of Information--Or, Should You Ever Pay for a Forecast?

### A. Efficient Market Theory and Expertise

A critical building block in microeconomic theory is the role of prices in aggregating information. A substantial literature in economics and finance deals with the process by which information is reflected in prices and its consequences for investors. [5] In the most simple, frictionless, textbook economy where information is freely available to all, it is clear that no one will pay for information. Furthermore, there will be no optimal strategy for firms or investors to follow; each investment is fairly priced relative to its risk and the available information.

In the real world, information is costly to collect. This fact implies that production of information will be limited to the point where the marginal cost and marginal benefit from an additional unit of information are equalized. While information may be costly to generate, there are enormous economies of scale in the distribution of existing information (e.g., via newspapers, television, or news wires). An implication of the above is that investors may earn the competitive rate of return on their investment in information only if they have monopolistic access to the information. Once the information

is publicly available (i.e., a public good), it is reflected in prices and of no further value. [6]

The conventional wisdom on the value of information and the existence of (forecasting) expertise seems to have completed a cycle. At the risk of generalization, prior to the 1960's the predominant image of the financial community was one of professionalism and expertise in picking winners. The mid-1960's through the 1970's witnessed an explosion of academic and professional research testing the efficient market hypothesis. The general impression left by this literature was that the performance record of many professional strategies and many "insiders" did not surpass the performance of naive and low-cost alternative strategies for investment. [7] As the evidence favoring market efficiency accumulated, the value of professional expertise seemed to decline. Passive strategies which emphasized low management fees and large diversification gains seemed to dominate more active strategies which emphasized forecasting individual stock returns.

However the extreme efficient markets view--that prices continuously reflect all available information and so superior performance is not possible--depends on a very strict set of assumptions. [8] In the past few years, academic research has attempted to explore models which relax some of these assumptions. The results are shifting the academic view back toward

a view more palatable to the financial community-i.e. there do exist rational models of behavior in which investors will seek out and pay for professional advice.

The early literature on market efficiency explicitly recognized this point by grouping empirical research into weak, semi-strong, and strong form tests to describe tests based on various information sets--historical prices, public information, and all available information. Several studies (Lorie and Niederhoffer 1968, Scholes 1972, McDonald 1973, and Jaffe 1974) report evidence which suggests that insiders can and do earn unusual returns relative to the market.

More recent research by Grossman and Stiglitz (1976) has introduced an explicit cost for information. Costly information implies that investors will not collect all information, so markets will never be fully efficient (i.e. strong-form). In the Grossman/Stiglitz model, those who chose to be informed earn higher profits than those who chose to remain uninformed. But the greater profit is only to compensate for the cost of information. As long as the information collection industry is competitive with free entry and exit, there will be no excess returns earned by collecting information. However, if the information industry is not fully competitive, then information takes on an "inside" character and excess returns are possible.

While this is one explanation for investor purchases of information, there are at least two unanswered questions.[9] First, to the extent that the WSJ tends to survey specific analysts, these analysts should be able to charge a higher price since their recommendations (potentially and not initially) will receive a wider distribution. A second problem is "selection bias". There is evidence that those recommendations which reach the WSJ have value, but how many others were not selected? And how does the WSJ make its selections? We may be back in the Keynesian beauty contest.

Another recent approach to market efficiency which allows for some individuals to outperform the market is developed in Figlewski (1978a, 1978b). Traders in Figlewski's model have heterogeneous information, but they also are allowed diverse price expectations, risk aversion, predictive ability and wealth. Based on these factors, traders make their investments in period 1. Traders with superior (inferior) ability generally incur an increase (decrease) in wealth in period 2. The transfer of wealth ("dollar votes") toward traders with superior track records gives the market a dynamic property and long-run tendency to full efficiency.

An implication of this analysis is that traders with superior ability earn unusual returns relative to the market. Once again, if there is a market for trading skills--e.g. expertise can be increased through schooling or on-the-job training--then the trader may earn only the fair rate of return based on his investment.

A recent study on the value of information is reported by Lloyd-Davies and Canes (1978). The authors select the Wall Street Journal and its "Heard on the Street" column for their data base. This column summarizes information (e.g., earnings estimates, stock price projections) about specific firms recently prepared by leading financial analysts. Lloyd-Davies and Canes find that in the twenty days prior to the Wall Street Journal publication, there is some small (but significant) price movement in the direction projected by the analyst, but the major (and significant) move comes on the publication date.

Lloyd-Davies and Canes rationalize these results with the following scenario. In the initial round, the financial analysts' information and recommendations reach only a small group of investors with limited capital. Because of portfolio considerations, they will not commit a large fraction of their capital to any single asset. In some sense, then, these insiders stop short in placing a fair value on the asset because this would add excessive diversifiable risk to their portfolios. When the information is published in the Wall Street Journal, more capital is attracted to the asset and the portfolio constraint is no longer binding. The asset price now"fully reflects" the now public information. Those who paid for early access to the information earn a return.

But if there is no market for expertise--e.g. traders are endowed with non-transferable skills--then the trader may capture economic rents based on his special endowment.[10]

B. Information in the Foreign Exchange Market

It is important to consider what types of information might be worth collecting in order to forecast exchange rates. In this regard, it is interesting to contrast how the production and distribution of information differs in the foreign exchange market and the U.S. securities market. Since the great majority of stock price variation is explained by firm specific and industry specific factors, information on these variables is extremely important to investors. The Securities Exchange Commission requires firms to report extensive data on their operations. Accounting procedures are largely standardized. Brokers cannot act on inside information; they must make it public. If information appears contradictory or if rumors appear to be the cause of speculative price movements, the SEC can suspend trading and require the firm to make a clarifying statement.

In contrast, foreign exchange market behavior depends mainly on country specific or world specific factors. These factors may be determined by political forces rather than market forces. There is no international watchdog agency to promote the distribution of information. Institutions, accounting standards, and accuracy of data vary greatly. Traders rely on inside information and are not required to publicize this information.

Given the contrasting character of these market institutions, it could be argued that a larger fraction of information is publicly available in the stock market than in the foreign exchange market. As a result, the diversity of beliefs about individual currencies is likely to be greater than the diversity of beliefs about individual stocks.

Another important factor which pertains to currency forecasting is the link between basic information and the forecast. It is very often assumed that if all information is efficiently reflected in today's forward rate ($F_{t,n}$), then the forward rate is the optimal, publicly available forecast of the future spot rate ($S_{t+n}$). This argument ignores the possibility that a risk premium or transaction costs may exist, so that the true forward-spot relationship is

$$(1) \quad S_{t+n} = F_{t,n} + P_t(\underline{X}) + T_t + U_t$$

where $P_t(\underline{X})$ is a risk premium which depends on other variables, $\underline{X}$. $T_t$ is a transaction costs measure. $U_t$ is a random error term.

If (1) is the correct relationship, then advisory services should be expected to produce forecasts which are more accurate than the forward rate. As a result, users of these forecasts will earn speculative returns, but it remains to be shown that these returns are large relative to the risk incurred. This is an important issue which will be brought up again in the next section.

We conclude that credible models of market behavior exist which allow for investments in information and yet remain consistent with market efficiency. Theory also permits investors to be endowed with a range of analytical skills or to occupy preferred locations in the market, both of which characteristics may not be tradeable. There are clearly numerous examples of inside information leading to unusual profits. However, it is by no means clear that the foreign exchange market produces the optimal amount of information--or equivalently, whether additional investments in information will lead to a profit.

## III. Analyzing Foreign Exchange Forecasts

The analysis of foreign exchange forecasts is a tricky procedure. Without direct information on the costs of forecasting errors or on the investor's utility of wealth, there is not a uniform procedure for analyzing different forecasting methods. There is agreement that, in some sense, the forecast should "beat the market." There are two general approaches to determine if an advisory service possesses "expertise." First, we can examine various statistical properties of the forecast errors. Second, we can calculate the speculative returns earned by using the forecast.

## Statistical Analysis of Forecast Errors

Under a broad range of conditions, a comparison of simple summary statistics can be used to distinguish forecasts. For example, to maximize utility, investors with a symmetric linear loss function should select the forecast with the minimum mean absolute error while investors with a symmetric quadratic loss function should select the forecast with the minimum mean squared forecast error. However, the investor's loss function may be asymmetric or discontinuous at a point in time (e.g. the investor welcomes profits but cannot lose more than some amount without losing his job or declaring bankruptcy) or it can be variable over time (e.g. small losses over nine consecutive periods are acceptable as long as the investor is positioned to catch the big exchange rate move in period ten). In these latter cases, other criteria apply for selecting a forecasting model. [11]

Figure 1 illustrates a potential pitfall if forecasts are judged on the basis of mean or mean squared errors. Assume today's forward rate is \$2.00 and two alternative forecasts of the future spot rate are $S_1$=\$1.99 and $S_2$=\$2.08. If the actual spot rate turns out to be \$2.02, the second forecast ($S_2$) is superior even though it resulted in a larger forecast error because it advised investors to take long and profitable forward sterling positions.

Consequently, when investors are interested only in the sign of their profits the fraction of periods where the forecast correctly predicts only the direction of movement in the exchange rate, becomes a valid criterion for judging forecasts. Direction can be defined relative to the current spot rate ($S_t$), the current forward rate ($F_t$) or some other

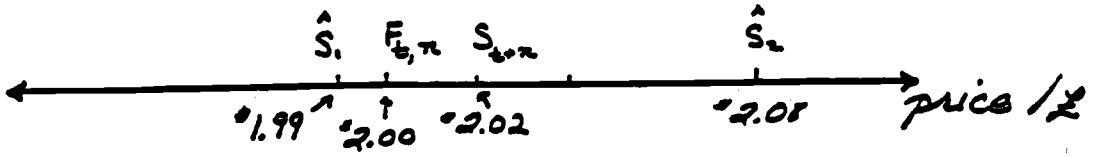


Figure 1: Illustrating a Pitfall in Forecast Error Analysis

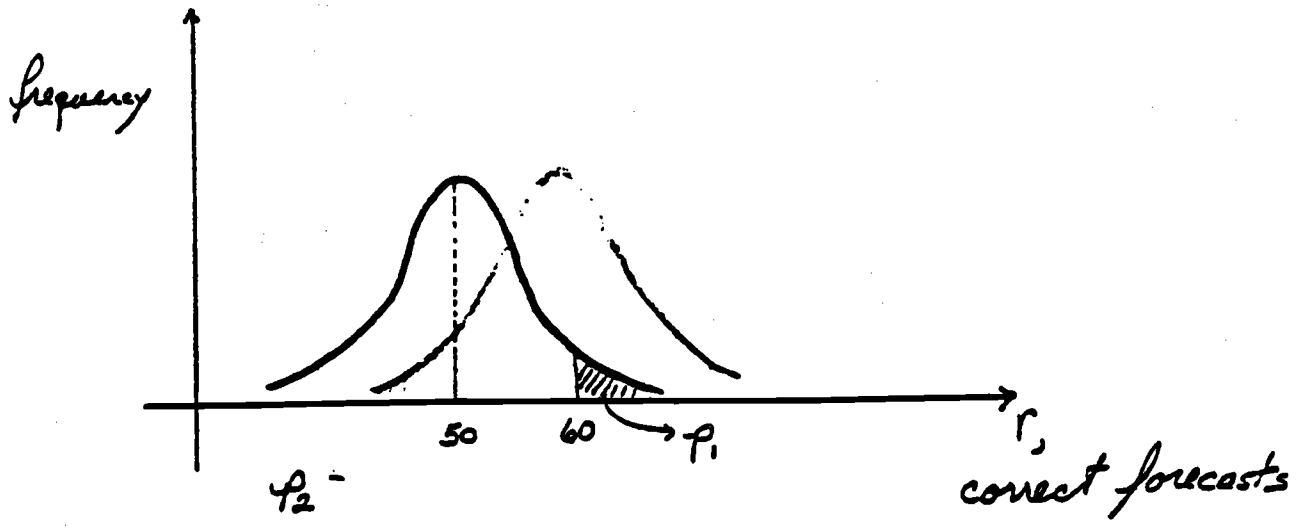


Figure 2: Illustrating a Test for Advisory Service Expertise

decision variable. (e.g. the forward rate plus a risk premium as in (1) ). An analysis of direction relative to the current forward rate would be a conservative test if the market price includes a risk premium.

We can construct the following test. We wish to estimate the probability (p) of correct advice in any period and then to infer whether this probability is greater than one-half. More formally, we are testing [12]

$H_o$: $p=0.5$ (advisory service has no expertise)

$H_1$: $p>0.5$ (there is forecasting expertise)

For example, in a sample of n=100 observations, assume that the advisory service produces r=60 correct forecasts. The probability ($p_1$) that this 60% track record could have occurred under the null hypothesis is 2.3%. Therefore $\hat{p}=r/n$ is one measure of forecasting expertise and $p_1$ is a measure of our confidence that p is greater than 0.5. (the type I error probability). In addition, we can calculate the probability ($p_2$) that we judge a service to have no expertise ($p<0.5$) given that the true probability is p=0.6. The probability ($p_2$) therefore is the chance of incorrectly failing to reject the null hypothesis (the Type II error probability)

## Speculative Return and Risk

Although the previous techniques may offer conservative tests for forecasting expertise, it is not realistic to assume that investors are interested only in the expected sign of their profits. The expected value of profits and higher moments of the distribution may also play a role. A stronger test of forecasting expertise is to compare the performance we would have obtained using the forecast relative to the performance of an alternative approach. The forecast is useful if it improves the investor's return/risk ratio.

The terms "return" and "risk" require special attention as they apply to the foreign exchange market. If the investor uses the forecast for forward speculation, his amount of profit will be

(2) $X W (S_{t+1} - F_t)$

where X = number of forward contracts

W = weight (+1 = forward purchases; -1 = forward sales).

The rate of return is $XW(W_{t+1} - F_t)/MXF_t$ where M is the fraction required for margin. Without loss of generality we can assume that M = 1 so that the rate of return is [13]

(3) $W (S_{t+1} - F_t)/F_t.$

If the investor choses to speculate in the spot market by taking a long position in DM, for example, he must first borrow U.S. dollars, paying the cost $i_\$$. [14] The investor now purchases DM in the spot market (at the rate $1/S_t$), invests the DM to return $i_{DM}$ and sells the entire proceeds in the future at rate $S_{t+1}$. The investor's rate of return in excess of costs is

(4) $S_{t+1}\,(1 + i_{DM}) \;/\; S_t\,(1 + i_{\$})$

When the interest rate parity theory holds so that $F_t/S_t = (1 + i_{\$})/(1+i_{DM})$ and in the case where W=1, expressions (3) and (4) are equal. The equality between spot and forward speculation is well known (Tsiang, 1959), but this exposition highlights that any positive return in (3) or (4) is unusual, since the cost of the investment has already been netted out. In the case where the cost $i_{\$}$ reflects the risk of the proposed foreign exchange speculation, the profit is unusual in a risk adjusted sense also. [15]

Ideally, we would like to know the risk adjusted cost of capital for speculation (i.e. open positions) in the foreign exchange market. In this case we could make a direct test for unusual returns based on advisory service forecasts. However, general equilibrium models for pricing foreign exchange risk are still open to considerable dispute, so we must consider more heuristic alternative approaches. [16]

One approach is to calculate a series of speculative returns and to measure the covariability of these returns with some market portfolio. Roll and Solnik use this approach and adopt a basket of currencies as the market portfolio. The covariance statistic provides a measure of the systematic risk of a currency position. In this framework, speculative returns are unusual if they are (1) large relative to transaction costs, (2) large relative to a risk measure, and (3) consistent over time.

A second technique proposed by Levich (1977) is to calculate the amount of profit

(5) $\sum_{i=1}^{N} | S_{t+1,i} - F_{t,i} |$

that an investor could earn over N periods if he had perfect information in every period. Levich shows that the ratio

$$(6) \qquad H = \sum_{i=1}^{N} W_i(S_{t+1,i}-F_{t,i}) \Big/ \sum_{i=1}^{N} |S_{t+1,i}-F_{t,i}|$$

has expected value (2p-1) and variance 4p(1-p)/n where p is the probability of choosing $W_i$ correctly in any period and n is the number of independent sample observations. For example, a forecast which leads to the correct position in half of the periods has p=0.5 and E(H)=0.0. "Unusual"profits correspond to the case where H is greater than zero or p is greater than one-half. [17]

## Discussion of these Procedures

Statistical analysis of foreign exchange forecasts very often will compare their results with the forward rate. This assumes that the forward rate has some desirable property--that it is unbiased or the minimum MSE forecast which is publicly available. Research reported by Bilson and Levich (1977) and Cornell (1977) cannot reject this assumption. However, an alternative hypothesis--that the forward rate reflects a risk premium which is highly volatile and changes sign--is also consistent with the data. In this second case, the forward rate is not a minimum MSE forecast and we would not expect it to have a smaller MSE than forecasts published by professional analysts.

A second issue relates the investor use of forecasts to their analysis. Very often, currency analysts generate forecasts on a currency-by-currency basis. Furthermore, the analysis of these forecasts and advice on how to utilize them are often also organized by individual currencies. And typically, exchange rate changes are not perfectly correlated. It seems therefore, that currency forecasts and their analysis often encourage currency-by-currency thinking. In developing this argument, Makin (1978)

suggests that firms which concentrate on individual currencies may be sacrificing important diversification gains. Granting that in theory shareholders can diversify exchange risk by themselves, Makin argues that the revealed preference of financial managers is adamently in favor of risk reduction. This suggests that currency forecasts be anaylzed as a group and not individually.

## IV. Empirical Methodology and Results

### A. Data Description

In this section we will analyze currency forecasts provided by nine leading foreign exchange advisory services. While several of these services have given permission to have their names attached to their empirical results, the identity of the advisory service is not important for the purpose of testing our null hypotheses on forecast accuracy and the availability of unusual speculative returns. Therefore, I have elected to refer to the advisory services only by number.

The forecasts and the services display a wide range of characteristics which will make data computations and statistical comparisons somewhat difficult. For example, some services produce a quarterly average forecast for one to six or eight quarters ahead; other services report an end-of-month forecast for the next four quarters. Some services adhere to a strict production schedule and publish forecasts at regular one-month intervals; other services follow a less strict time schedule and publish forecasts at irregular intervals ranging from three weeks to, say, eight or nine weeks. Some of the characteristics of the advisory services in our

sample are summarized in Table 1.

A second important set of data for this study is the time series of spot and forward exchange rates which we use for the standard of prediction performance. For this purpose we use the Harris Bank Weekly Review which reports the closing bid prices for spot exchange, and one-, three-, six-, and twelve-month forward contracts for nine major currencies.[18] This data set begins in January 1967 and contains 626 weekly observations through February 2, 1979.

B. Research Methodology

There are several important methodological issues which must be discussed before we proceed to discuss the results. The first issue involves the time or date of the forecast. For example, a service may run their computer model on January 12 ($t_1$). The forecasts are combined with other data for a published report dated January 19 ($t_2$). Finally, the report is mailed to subscribers who receive it on January 26 ($t_3$). To analyze a forecast we need to know the horizon (i.e. how many weeks ahead we are forecasting) which implies that we must know the forecast date. Is it $t_1$, $t_2$, or $t_3$? For academic purposes, we should chose $t_1$, because the service used only information available at $t_1$ to make its forecast. However, for practical investment purposes, we cannot use the forecast until $t_3$, and so we should calculate speculative returns based on the transactions we can make at $t_3$, but still recognize that the forecast date is $t_1$.

In this paper, our calculations assume that the forecasts are effective on $t_1$ and that subscribers can then transact at prices prevailing on the following Friday. We require this assumption

because our spot and forward exchange rate data are end-of-week prices.

A second methodological problem arises from the fact that many services generate a quarterly average forecast. While we can calculate the average spot exchange rate in a quarter to suggest a measure of forecasting accuracy, we cannot easily use this statistic to measure the accuracy of the service relative to some other predictor (e.g., the forward rate) or to measure the speculative profits available by using the forecasts. We therefore elect to convert the quarterly average forecasts into a set of point estimates of the future spot rate at various horizons.

Our procudure is to assume that the quarterly average forecast corresponds to the point forecast for the midpoint of the quarter. For example, let quarters I, II, III, and IV for a given year correspond to weeks 1-13, 14-26, 27-39, and 40-52, respectively. Quarterly average forecasts for these quarters are assumed to correspond to point forecasts for weeks 7, 20, 33, and 46, respectively. Given the current spot rate, we use linear interpolation to calculate the implied 4, 13, 26, and 52 week ahead forecasts. We chose these dates to be consistent with the term structure of forward rates provided by the Harris Bank Weekly Review.

An example of this procedure is illustrated in Figure 3. When point estimate forecasts -- say, one month ahead or end of quarter -- are provided directly by the service, we can use linear interpolation directly to calculate the implied term structure of forecasts.

Consistent with our remarks in section III, the analysis considers both the distribution of forecast errors and the

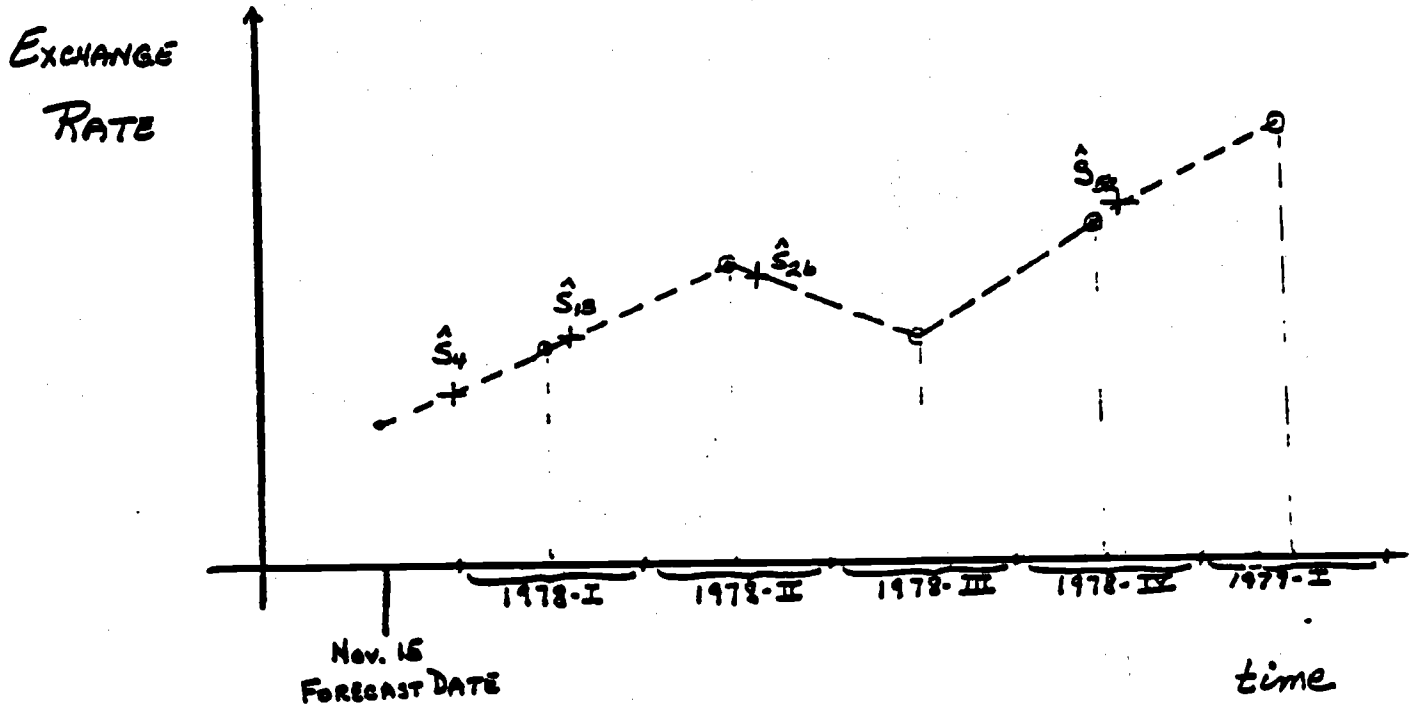


Figure 3 : Construction of Point Forecasts ($\hat{S}$) from Quarterly Average Forecasts.

speculative returns available by using the forecast. Forecast errors are calculated as

$$E_{t,n} = (S_{t+n} - \hat{S}_{t,n})/S_{t+n}$$

where $S_{t+n}$ is the future spot rate, $\hat{S}_{t,n}$ is the n-period ahead forecase made at time t, and $E_{t,n}$ is the resulting error. Note that the errors are indexed by the point in time when the forecast is made (t) rather than the time when the result is realized (t+n).

To calculate speculative returns, we select the weights according to a simple criterion:

$$W_t = \begin{cases} +1 & \text{if } \hat{S}_{t,n} > F_{t,n} \\ -1 & \text{if } \hat{S}_{t,n} < F_{t,n} \end{cases}$$

The decision to invest a lump sum amount suggests that our investors are risk neutral and consider each currency individually or form equally weighted currency portfolios. If investors take into account other factors (e.g., the magnitude $\hat{S}_{t,n} - F_{t,n}$, the standard error of the forecast $\hat{S}_{t,n}$ or the correlation of forecast errors across currencies), a different set of weights would result.

C. Empirical Results

In the current version of this paper, our analysis is restricted to the entire sample period for each advisory service. Since the time period and sample size are not comparable for all advisory services (see Table 1), it is not valid to make direct comparisons of the results across currencies.

The empirical results of this study are summarized in Tables 2-6. Table 2 reports the ratio

$$\text{Ratio} = \frac{\text{MSE (advisory service forecast)}}{\text{MSE (forward rate)}}$$

where the mean squared errors (MSE) are calculated over the same sample period. Values of "Ratio" less (greater) than 1.0 suggest that the advisory service forecast was more (less) accurate than the forward rate prediction. The results indicate that most values of "Ratio" are greater than 1.0, ranging from 53% of the entries in the three-month panel to 71% of the entries in the six-month panel.

However, several services indicate a pattern across horizons. At the one-month horizon, services 5 and 9 generally have smaller MSE than the forward rate, while service 1 has a greater MSE for all currencies. At the twelve-month horizon, however, this pattern is reversed, so that service 1 appears generally more accurate than the forward rate while services 2, 5, and 9 generally have MSE greater than the forward rate. These results suggest that judgmental forecasts may be more accurate in the short-run and econometric forecasts may be more accurate in the long-run.

Table 3 reports the mean speculative return earned by an investor who followed a naive trading strategy using the forecasts. In the one-month panel, 72% of the entries are positive. This percentage declines steadily to 46% positive entries in the twelve-month panel. Seven of the nine services are profitable at the one-month horizon. At the twelve-month horizon, only two services are profitable across all currencies; both of these services use econometric forecasting methods.

The ratio of speculative profits to perfect information profits (the H-statistic from equation 6) is reported in Table 4. Note that as expected, the sign of the entries agree in Table 3 and

4. Only 14 of the entries (or 18%) in the one-month panel report H greater than 0.6. These large H-statistics are concentrated in services 3, 5, 8, and 9. In the twelve-month panel, 12 of the entries (or 17%) are greater than 0.6. One-half of these values are concentrated in service 1.

As we explained in section III, the H-statistic depends on both correct prediction and the distribution of speculative returns. In order to concentrate on the prediction issue, we calculate the fraction of forecasts which are correct relative to the forward rate.

$$\hat{p} = r/n$$

where r = number of correct forecasts
n = sample size

Sample estimates of $\hat{p}$ are reported in Table 5. The calculations are based on all sample observations (i.e. a dependent sample) in order to get a more accurate estimate of the true $\hat{p}$[19]. For each service, the results are aggregated across currencies.

Table 5 suggests one result we have mentioned before; namely, the equation based forecasts (services 1 and 3) appear to be more accurate in the long-run while the judgmental forecasts (services 2,6,7,9) appear to lose accuracy with longer horizons. The Swiss franc appears to be the most difficult currency to forecast as most of the estimates of $\hat{p}$ are less than 50%. Using the same criterion, the Italian lira appears to be the easiest currency to predict. Service 9 appears to have the best overall record at the one-month horizon, while service 1 appears to have the best overall record at the longer horizons.

Our interest, however, is to determine if the values of $\hat{p}$ in Table 4 are unusual and indicate expertise. Our approach,

as we described in Section III, is to calculate the probability ($p_1$) of observing as many as (r) correct forecasts out of (n) observations, if the true probability of a correct forecast is 0.5. The test requires independent sample observations[20].

The estimates of $p_1$ are reported in Table 5. For example, for service 6 the one-month Italian lira forecast was "correct" in 16 of 22 independent periods. Under the null hypothesis ($p = 0.5$), the probability of 16 or more correct forecasts in 22 periods is 1.6%. Similarly, for service 1 the six-month German mark forecast was correct in 6 of 7 independent periods. The probability of a track record this good or better is 6.2%. Small values of $p_1$ therefore indicate that the advisory service has expertise in judging the direction of the future spot rate relative to the current forward rate.

The results are also aggregated across all currencies. It is not clear that this aggregated sample represents independent observations, since the advisory service may use similar models, personnel, or data to arrive at their forecasts. In addition, currency changes are not independent. Therefore, our results for each service aggregated across currencies are valid only if the independence assumption is satisfied.

The aggregated results suggest that several currencies have superior track records. For example, for service 9 at the one-month horizon 92 of 153 forecasts (or 60%) were correct. The implied value of $p_1$, under the null hypothesis is 0.6%. For service 1 at the twelve-month horizon, 20 of 27 forecasts (or 74%) were correct. The implied value of $p_1$ under the null hypothesis is 2.1%.

## V. Summary and Conclusions

Financial theory allows for the possibility that investors may earn unusual returns relative to those generally available in the market. In order to earn unusual returns, investors must have access to information or analytical skills that are not generally available and reflected in market prices. While this is a theoretical possibility, it is not likely in a highly competitive market.

The empirical section of this paper analyzed the accuracy of a wide range of foreign exchange forecasts prepared by advisory services. Our purpose was both to examine the accuracy of these forecasts and to measure the speculative profits based on these forecasts. Based on analysis of mean squared errors, our results suggest that most forecasts are not as accurate as the forward rate.

Our analysis of the speculative returns and the fraction of "correct" forecasts, however, does suggest that advisory services have beaten the forward rate in the past. The record of correct forecasts and percent of perfect information profits are too good for some services to be explained by chance. These unusual results are more convincing for services with a long track record.

It should be cautioned that if the forward rate contains a risk premium, then we expect advisory service models to beat the forward rate according to the tests we have outlined. In this case we must measure speculative returns relative to a risk measure. While advisory service forecasts may lead to profits, they may not be unusual after adjusting for risk.

Table 1: Summary of Background Information on Advisory Services

| Service | Start Date | End Date | No. of Observations | Currencies Forecast(*) Number | C$ | BP | BF | FF | DM | IL | DG | SF | JY | Forecast Methodology |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | April 1975 | February 1979 | 47 | 9 | * | * | * | * | * | * | * | * | * | Econometric |
| 2 | January 1974 | April 1976 | 40 | 9 | * | * | * | * | * | * | * | * | * | Judgmental |
| 3 | November 1976 | May 1978 | 13 | 9 | * | * | * | * | * | * | * | * | * | Econometric |
| 4 | February 1975 | September 1978 | 27 | 8 | * | * | * | * | * | * | * | No | * | Econometric |
| 5 | November 1977 | July 1978 | 12 | 7 | * | * | No | * | * | * | No | * | * | Judgmental |
| 6 | July/November 1975 | May/July 1978 | 20-24 | 9 | * | * | * | * | * | * | * | * | * | Judgmental |
| 7 | March 1976 | January 1979 | 25 | 9 | * | * | * | * | * | * | * | * | * | Judgmental |
| 8 | March 1978 | May 1978 | 3 | 9 | * | * | * | * | * | * | * | * | * | Econometric |
| 9 | February 1976 | July 1977 | 17 | 9 | * | * | * | * | * | * | * | * | * | Judgmental |

NOTE: C$ = Canadian dollar
BP = British pound
BF = Belgian franc
FF = French franc
DM = German mark
IL = Italian lira
DG = Dutch guilder
JY = Japanese yen
SF = Swiss franc

# TABLE 2

RATIO = MSE(advisory service) / MSE(forward rate)

TABLE #1 OF STATISTIC 3 FOR HORIZON 1 MONTH

| COUNTRY | SERVICE 1 | SERVICE 2 | SERVICE 3 | SERVICE 4 | SERVICE 5 | SERVICE 6 | SERVICE 7 | SERVICE 8 | SERVICE 9 |
|---|---|---|---|---|---|---|---|---|---|
| C$ | 1.230 | 1.063 | 1.340 | 0.834 | 1.120 | 1.060 | 1.692 | 0.957 | 0.669 |
| BP | 1.202 | 1.260 | 0.636 | 1.268 | 0.978 | 0.741 | 1.497 | 0.864 | 0.819 |
| BF | 1.220 | 0.995 | 1.306 | 1.045 | 999.000 | 1.108 | 1.345 | 51.948 | 1.306 |
| FF | 1.262 | 1.334 | 0.798 | 1.029 | 0.992 | 1.657 | 1.260 | 0.813 | 1.592 |
| DM | 1.137 | 0.944 | 1.247 | 1.515 | 0.634 | 1.095 | 1.011 | 0.697 | 0.918 |
| IL | 1.447 | 1.106 | 0.268 | 0.997 | 0.907 | 0.658 | 45.026 | 1.244 | 0.844 |
| DG | 1.124 | 1.001 | 1.188 | 1.480 | 999.000 | 1.152 | 1.505 | 50.915 | 0.611 |
| SF | 1.151 | 1.024 | 1.630 | 999.000 | 0.886 | 0.956 | 1.131 | 0.600 | 1.269 |
| JY | 1.292 | 1.124 | 1.145 | 1.043 | 0.990 | 0.883 | 999.000 | 1.231 | 0.705 |

TABLE #1 OF STATISTIC 3 FOR HORIZON 3 MONTH

| COUNTRY | SERVICE 1 | SERVICE 2 | SERVICE 3 | SERVICE 4 | SERVICE 5 | SERVICE 6 | SERVICE 7 | SERVICE 8 | SERVICE 9 |
|---|---|---|---|---|---|---|---|---|---|
| C$ | 1.821 | 1.193 | 1.870 | 0.833 | 0.953 | 1.233 | 1.579 | 14.527 | 0.458 |
| BP | 1.250 | 1.603 | 0.513 | 1.097 | 0.855 | 0.962 | 1.336 | 0.088 | 1.132 |
| BF | 0.784 | 0.942 | 1.387 | 1.359 | 999.000 | 1.563 | 1.838 | 0.670 | 1.053 |
| FF | 1.129 | 1.363 | 0.217 | 1.039 | 0.951 | 2.237 | 1.948 | 0.885 | 3.216 |
| DM | 0.842 | 0.793 | 1.486 | 2.157 | 0.886 | 1.275 | 1.495 | 0.130 | 0.957 |
| IL | 0.870 | 1.194 | 0.189 | 0.849 | 0.799 | 0.993 | 0.921 | 0.912 | 0.782 |
| DG | 0.759 | 0.888 | 1.267 | 1.688 | 999.000 | 1.295 | 1.998 | 0.227 | 0.672 |
| SF | 0.937 | 1.237 | 1.558 | 999.000 | 1.070 | 0.967 | 1.128 | 1.622 | 1.393 |
| JY | 1.293 | 1.098 | 1.022 | 1.408 | 0.923 | 0.794 | 999.000 | 0.915 | 0.626 |

TABLE #1 OF STATISTIC 3 FOR HORIZON 6 MONTH

| COUNTRY | SERVICE 1 | SERVICE 2 | SERVICE 3 | SERVICE 4 | SERVICE 5 | SERVICE 6 | SERVICE 7 | SERVICE 8 | SERVICE 9 |
|---|---|---|---|---|---|---|---|---|---|
| C$ | 1.899 | 1.029 | 2.897 | 0.806 | 1.267 | 1.214 | 1.614 | 6.305 | 0.397 |
| BP | 1.274 | 2.276 | 0.672 | 1.422 | 1.351 | 1.050 | 1.464 | 0.456 | 1.434 |
| BF | 0.329 | 0.974 | 1.591 | 0.980 | 999.000 | 2.035 | 1.729 | 3.073 | 1.120 |
| FF | 0.945 | 1.590 | 0.207 | 0.876 | 1.298 | 1.661 | 1.769 | 1.032 | 3.686 |
| DM | 0.382 | 0.852 | 1.805 | 1.886 | 1.793 | 1.742 | 1.892 | 1.654 | 1.407 |
| IL | 1.427 | 1.435 | 0.188 | 0.849 | 1.143 | 1.073 | 0.897 | 1.106 | 0.620 |
| DG | 0.319 | 0.939 | 1.351 | 1.352 | 999.000 | 1.856 | 2.093 | 1.777 | 0.865 |
| SF | 0.616 | 1.665 | 1.919 | 999.000 | 1.622 | 1.033 | 1.241 | 3.060 | 1.301 |
| JY | 1.296 | 1.181 | 1.108 | 1.318 | 1.215 | 0.921 | 999.000 | 1.071 | 0.903 |

TABLE #1 OF STATISTIC 3 FOR HORIZON 12 MONTH

| COUNTRY | SERVICE 1 | SERVICE 2 | SERVICE 3 | SERVICE 4 | SERVICE 5 | SERVICE 6 | SERVICE 7 | SERVICE 8 | SERVICE 9 |
|---|---|---|---|---|---|---|---|---|---|
| C$ | 2.047 | 1.217 | 2.911 | 1.109 | 1.522 | 1.198 | 1.924 | 999.000 | 0.536 |
| BP | 1.040 | 2.766 | 0.432 | 1.482 | 2.857 | 1.002 | 1.643 | 999.000 | 1.410 |
| BF | 0.215 | 1.089 | 1.511 | 0.712 | 999.000 | 1.897 | 1.685 | 999.000 | 1.277 |
| FF | 0.002 | 1.680 | 0.337 | 0.002 | 1.134 | 1.302 | 2.397 | 999.000 | 1.431 |
| DM | 0.235 | 1.182 | 1.801 | 1.293 | 1.871 | 2.004 | 2.182 | 999.000 | 1.680 |
| IL | 0.378 | 1.342 | 0.143 | 1.423 | 0.995 | 0.751 | 0.862 | 999.000 | 0.480 |
| DG | 0.181 | 1.189 | 1.263 | 1.096 | 999.000 | 1.991 | 2.219 | 999.000 | 1.414 |
| SF | 0.647 | 2.183 | 1.559 | 999.000 | 1.592 | 1.217 | 1.055 | 999.000 | 1.365 |
| JY | 1.473 | 1.302 | 0.971 | 1.201 | 1.062 | 0.850 | 999.000 | 999.000 | 0.960 |

# Table 3

Mean Speculative Return, Per Period

TABLE #1 OF STATISTIC 4 FOR HORIZON 1 MONTH

| COUNTRY | SERVICE 1 | SERVICE 2 | SERVICE 3 | SERVICE 4 | SERVICE 5 | SERVICE 6 | SERVICE 7 | SERVICE 8 | SERVICE 9 |
|---|---|---|---|---|---|---|---|---|---|
| CS | -0.001 | 0.002 | -0.006 | 0.001 | -0.004 | 0.003 | 0.003 | 0.003 | 0.005 |
| BP | 0.001 | -0.002 | 0.014 | 0.000 | 0.015 | 0.006 | -0.006 | 0.003 | 0.007 |
| BF | 0.008 | 0.003 | -0.007 | -0.002 | 999.000 | 0.005 | -0.000 | 0.010 | 0.001 |
| FF | 0.003 | 0.001 | 0.008 | 0.005 | 0.016 | -0.004 | 0.004 | 0.017 | -0.003 |
| DM | 0.005 | 0.004 | 0.001 | -0.005 | 0.013 | 0.007 | 0.001 | 0.020 | 0.001 |
| IL | 0.007 | 0.002 | 0.011 | 0.003 | 0.013 | 0.009 | 0.004 | -0.006 | 0.018 |
| DG | 0.008 | 0.001 | -0.001 | -0.003 | 999.000 | 0.000 | -0.002 | 0.001 | 0.008 |
| SF | -0.000 | 0.004 | -0.010 | 999.000 | 0.030 | 0.003 | -0.003 | 0.032 | 0.002 |
| JY | -0.002 | 0.004 | 0.003 | -0.003 | 0.018 | 0.011 | -0.011 | -0.011 | 0.008 |
| AVERAGE | 0.003 | 0.002 | 0.001 | -0.000 | 0.014 | 0.004 | -0.001 | 0.009 | 0.005 |

TABLE #1 OF STATISTIC 4 FOR HORIZON 3 MONTH

| COUNTRY | SERVICE | SERVICE | SERVICE | SERVICE | SERVICE | SERVICE | SERVICE | SERVICE | SERVICE |
|---|---|---|---|---|---|---|---|---|---|
| CS | -0.007 | 0.004 | -0.019 | 0.005 | -0.003 | 0.006 | 0.001 | 0.004 | 0.012 |
| BP | 0.000 | -0.020 | 0.045 | -0.003 | 0.028 | 0.012 | -0.002 | 0.043 | 0.000 |
| BF | 0.029 | 0.012 | -0.025 | -0.008 | 999.000 | -0.003 | -0.017 | 0.029 | 0.015 |
| FF | 0.017 | 0.003 | 0.029 | 0.003 | 0.039 | -0.015 | -0.000 | 0.035 | -0.009 |
| DM | 0.025 | 0.010 | -0.014 | -0.008 | 0.048 | 0.002 | -0.009 | 0.028 | 0.014 |
| IL | 0.031 | 0.008 | 0.035 | 0.035 | 0.048 | 0.012 | 0.013 | 0.020 | 0.026 |
| DG | 0.027 | 0.011 | 0.000 | -0.004 | 999.000 | -0.002 | -0.007 | 0.025 | 0.015 |
| SF | 0.009 | 0.003 | -0.043 | 999.000 | -0.033 | 0.031 | 0.002 | -0.000 | -0.002 |
| JY | -0.009 | 0.002 | 0.012 | -0.018 | 0.072 | 0.017 | -0.030 | 0.015 | 0.017 |
| AVERAGE | 0.014 | 0.004 | 0.002 | 0.000 | 0.028 | 0.007 | -0.006 | 0.022 | 0.010 |

TABLE #1 OF STATISTIC 4 FOR HORIZON 6 MONTH

| COUNTRY | SERVICE | SERVICE | SERVICE | SERVICE | SERVICE | SERVICE | SERVICE | SERVICE | SERVICE |
|---|---|---|---|---|---|---|---|---|---|
| CS | -0.020 | 0.005 | -0.028 | 0.015 | -0.018 | 0.008 | -0.002 | -0.032 | 0.033 |
| BP | 0.001 | -0.030 | 0.059 | -0.031 | -0.022 | -0.006 | -0.021 | 0.071 | -0.043 |
| BF | 0.054 | -0.006 | -0.047 | -0.006 | 999.000 | -0.030 | -0.017 | -0.061 | 0.009 |
| FF | 0.043 | 0.001 | 0.066 | 0.014 | 0.002 | -0.030 | -0.009 | 0.074 | -0.024 |
| DM | 0.046 | 0.003 | -0.019 | -0.019 | -0.021 | -0.016 | -0.026 | -0.052 | 0.011 |
| IL | 0.077 | 0.003 | 0.063 | 0.055 | 0.020 | 0.007 | 0.031 | 0.003 | 0.052 |
| DG | 0.050 | 0.008 | 0.019 | -0.001 | 999.000 | -0.014 | -0.008 | 0.046 | 0.018 |
| SF | 0.045 | -0.030 | -0.061 | 999.000 | -0.044 | 0.040 | -0.028 | -0.152 | -0.035 |
| JY | 0.032 | -0.013 | 0.008 | -0.055 | -0.058 | 0.012 | -0.085 | -0.043 | 0.019 |
| AVERAGE | 0.036 | -0.007 | 0.007 | -0.004 | -0.020 | -0.008 | -0.018 | -0.016 | 0.004 |

TABLE #1 OF STATISTIC 4 FOR HORIZON 12 MONTH

| COUNTRY | SERVICE | SERVICE | SERVICE | SERVICE | SERVICE | SERVICE | SERVICE | SERVICE | SERVICE |
|---|---|---|---|---|---|---|---|---|---|
| CS | -0.026 | 0.016 | -0.046 | 0.021 | -0.057 | 0.003 | -0.042 | 999.000 | 0.045 |
| BP | 0.039 | -0.082 | 0.113 | -0.047 | -0.063 | -0.008 | -0.057 | 999.000 | -0.068 |
| BF | 0.110 | -0.002 | -0.046 | 0.030 | 999.000 | -0.119 | -0.075 | 999.000 | -0.031 |
| FF | 0.098 | 0.010 | 0.150 | 0.038 | -0.045 | -0.053 | -0.080 | 999.000 | -0.041 |
| DM | 0.084 | -0.011 | -0.033 | 0.002 | -0.121 | -0.011 | -0.067 | 999.000 | -0.044 |
| IL | 0.161 | 0.017 | 0.156 | 0.002 | 0.118 | 0.068 | 0.041 | 999.000 | 0.090 |
| DG | 0.090 | 0.001 | 0.036 | 0.011 | 999.000 | -0.052 | -0.044 | 999.000 | -0.021 |
| SF | 0.091 | -0.097 | -0.071 | 999.000 | -0.211 | 0.011 | -0.135 | 999.000 | -0.080 |
| JY | 0.084 | -0.092 | 0.014 | -0.059 | -0.025 | 0.088 | -0.204 | 999.000 | 0.008 |
| AVERAGE | 0.081 | -0.027 | 0.030 | -0.000 | -0.058 | -0.008 | -0.074 | 0.0 | -0.016 |

# TABLE 4

## H- STATISTIC

## FRACTION OF "PERFECT INFORMATION PROFITS"

TABLE #1 OF STATISTIC 6 FOR HORIZON 1 MONTH

| COUNTRY | SERVICE 1 | SERVICE 2 | SERVICE 3 | SERVICE 4 | SERVICE 5 | SERVICE 6 | SERVICE 7 | SERVICE 8 | SERVICE 9 |
|---|---|---|---|---|---|---|---|---|---|
| CS | -0.062 | 0.279 | -0.655 | 0.148 | -0.376 | 0.359 | 0.287 | 0.261 | 0.519 |
| BP | 0.035 | -0.170 | 0.972 | 0.077 | 0.883 | 0.291 | -0.315 | 0.178 | 0.382 |
| BF | 0.444 | 0.205 | -0.514 | -0.490 | 999.000 | 0.326 | 0.004 | 0.774 | 0.077 |
| FF | 0.174 | 0.060 | 0.517 | -0.258 | 0.667 | -0.247 | 0.296 | 0.820 | -0.243 |
| DM | 0.322 | 0.254 | 0.049 | -0.106 | 0.748 | 0.464 | 0.055 | 0.784 | 0.115 |
| IL | 0.381 | 0.083 | 0.921 | -0.794 | 1.000 | 0.472 | 0.125 | -1.000 | 0.741 |
| DG | 0.445 | 0.078 | -0.097 | -0.454 | 999.000 | 0.011 | -0.100 | 0.039 | 0.565 |
| SF | 0.022 | 0.238 | -0.482 | 999.000 | 0.869 | 0.184 | -0.064 | 1.000 | 0.192 |
| JY | -0.148 | 0.254 | 0.131 | -0.206 | 0.540 | 0.620 | -0.643 | -0.381 | 0.622 |

TABLE #1 OF STATISTIC 6 FOR HORIZON 3 MONTH

| COUNTRY | SERVICE 1 | SERVICE 2 | SERVICE 3 | SERVICE 4 | SERVICE 5 | SERVICE 6 | SERVICE 7 | SERVICE 8 | SERVICE 9 |
|---|---|---|---|---|---|---|---|---|---|
| CS | -0.358 | 0.253 | -0.958 | 0.236 | -0.113 | 0.360 | 0.084 | 1.000 | 0.665 |
| BP | -0.010 | -0.464 | 1.000 | -0.038 | 0.447 | 0.221 | -0.050 | 0.991 | 0.046 |
| BF | 0.781 | 0.354 | -0.655 | -0.752 | 999.000 | -0.032 | -0.481 | 1.000 | 0.467 |
| FF | 0.610 | 0.121 | 1.000 | -0.306 | 0.635 | -0.554 | 0.022 | 0.832 | -0.440 |
| DM | 0.854 | 0.300 | -0.400 | -0.480 | 0.740 | 0.080 | -0.313 | 0.911 | 0.665 |
| IL | 0.706 | 0.145 | 1.000 | -0.287 | 1.000 | 0.170 | 0.288 | 1.000 | 0.591 |
| DG | 0.780 | 0.339 | -0.011 | -0.504 | 999.000 | -0.056 | -0.219 | 0.906 | 0.466 |
| SF | 0.198 | 0.083 | -0.596 | 999.000 | -0.338 | 0.627 | 0.149 | 0.025 | -0.083 |
| JY | -0.226 | 0.114 | 0.201 | -0.434 | 1.000 | 0.434 | -0.625 | 0.160 | 0.561 |

TABLE #1 OF STATISTIC 6 FOR HORIZON 6 MONTH

| COUNTRY | SERVICE 1 | SERVICE 2 | SERVICE 3 | SERVICE 4 | SERVICE 5 | SERVICE 6 | SERVICE 7 | SERVICE 8 | SERVICE 9 |
|---|---|---|---|---|---|---|---|---|---|
| CS | -0.599 | 0.152 | -1.000 | 0.447 | -0.516 | 0.259 | -0.021 | -1.000 | 0.998 |
| BP | 0.018 | -0.465 | 0.933 | -0.386 | -0.417 | -0.137 | -0.326 | 1.000 | -0.655 |
| BF | 0.853 | -0.102 | -0.735 | -0.775 | 999.000 | -0.448 | -0.198 | -1.000 | 0.087 |
| FF | 0.783 | 0.046 | 1.000 | -0.388 | 0.806 | -0.545 | -0.158 | 0.650 | -0.627 |
| DM | 0.989 | 0.037 | -0.377 | -0.923 | -0.361 | -0.411 | -0.527 | -1.000 | 0.241 |
| IL | 0.943 | -0.030 | 0.857 | -0.321 | 0.377 | -0.007 | 0.387 | 0.026 | 0.709 |
| DG | 0.927 | 0.132 | 0.347 | -0.773 | 999.000 | -0.246 | -0.105 | 1.000 | 0.322 |
| SF | 0.578 | -0.421 | -0.524 | 999.000 | -0.503 | 0.493 | -0.321 | -1.000 | -0.598 |
| JY | 0.475 | -0.143 | 0.031 | -0.436 | -0.475 | 0.188 | -0.994 | -0.204 | 0.273 |

TABLE #1 OF STATISTIC 6 FOR HORIZON 12 MONTH

| COUNTRY | SERVICE 1 | SERVICE 2 | SERVICE 3 | SERVICE 4 | SERVICE 5 | SERVICE 6 | SERVICE 7 | SERVICE 8 | SERVICE 9 |
|---|---|---|---|---|---|---|---|---|---|
| CS | -0.485 | 0.285 | -0.760 | 0.437 | -1.000 | 0.087 | -0.738 | 999.000 | 0.840 |
| BP | 0.309 | -0.667 | 0.959 | -0.370 | -1.000 | -0.035 | -0.524 | 999.000 | -0.566 |
| BF | 0.917 | -0.030 | -0.325 | -0.523 | 999.000 | -0.876 | -0.506 | 999.000 | -0.259 |
| FF | 0.987 | 0.120 | 1.000 | -0.909 | -0.264 | -0.492 | -0.730 | 999.000 | -0.517 |
| DM | 0.948 | -0.143 | -0.304 | -0.680 | -1.000 | -0.076 | -0.662 | 999.000 | -0.521 |
| IL | 1.000 | 0.055 | 1.000 | -0.224 | 1.000 | 0.392 | 0.236 | 999.000 | 0.583 |
| DG | 0.946 | 0.001 | 0.276 | -0.582 | 999.000 | -0.490 | -0.402 | 999.000 | -0.251 |
| SF | 0.705 | -0.753 | -0.307 | 999.000 | -1.000 | 0.120 | -0.769 | 999.000 | -0.587 |
| JY | 0.605 | -0.653 | 0.058 | -0.786 | -0.135 | 0.503 | -1.000 | 999.000 | 0.025 |

## TABLE 5: PERCENTAGE OF CORRECT FORECASTS (p = r/n) IN ALL SAMPLE OBSERVATIONS (DEPENDENT SAMPLES)

### HORIZON 1 MONTH

| CURRENCY | SERVICE => 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| CANADA | 33 | 58 | 23 | -- | -- | 60 | 58 | -- | 65 |
| U.K. | 49 | 38 | 92 | -- | -- | 64 | 33 | -- | 41 |
| BELGIUM | 69 | 55 | 31 | -- | -- | 63 | 54 | -- | 53 |
| FRANCE | 56 | 53 | 69 | -- | -- | 42 | 54 | -- | 41 |
| GERMANY | 62 | 43 | 46 | -- | -- | 68 | 54 | -- | 65 |
| ITALY | 64 | 55 | 92 | -- | -- | 73 | 46 | -- | 71 |
| NETHERLANDS | 69 | 48 | 54 | -- | -- | 55 | 46 | -- | 76 |
| SWITZERLAND | 44 | 53 | 38 | -- | -- | 48 | 38 | -- | 53 |
| JAPAN | 49 | 50 | 46 | -- | -- | 55 | -- | -- | 76 |
| SAMPLE SIZE | 45 | 40 | 13 | -- | -- | 22* | 24 | -- | 17 |
| ALL CURRENCY % | 55 | 50 | 55 | -- | -- | 58 | 48 | -- | 60 |
| SAMPLE SIZE | 405 | 360 | 117 | --- | --- | 197 | 192 | --- | 153 |

### HORIZON 6 MONTHS

| CURRENCY | SERVICE => 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| CANADA | 20 | 58 | 0 | -- | -- | 55 | 38 | -- | 94 |
| U.K. | 45 | 25 | 85 | -- | -- | 41 | 38 | -- | 18 |
| BELGIUM | 85 | 45 | 15 | -- | -- | 21 | 29 | -- | 47 |
| FRANCE | 80 | 50 | 100 | -- | -- | 25 | 48 | -- | 29 |
| GERMANY | 93 | 48 | 31 | -- | -- | 14 | 14 | -- | 71 |
| ITALY | 93 | 55 | 92 | -- | -- | 59 | 57 | -- | 82 |
| NETHERLANDS | 90 | 53 | 62 | -- | -- | 32 | 29 | -- | 47 |
| SWITZERLAND | 70 | 48 | 23 | -- | -- | 62 | 48 | -- | 53 |
| JAPAN | 53 | 45 | 62 | -- | -- | 55 | -- | -- | 82 |
| SAMPLE SIZE | 40 | 40 | 13 | -- | -- | 22* | 21 | -- | 17 |
| ALL CURRENCY % | 80 | 47 | 52 | -- | -- | 40 | 38 | -- | 58 |
| SAMPLE SIZE | 360 | 360 | 117 | --- | --- | 197 | 168 | --- | 153 |

### HORIZON 3 MONTHS

| CURRENCY | SERVICE => 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| CANADA | 35 | 50 | 15 | -- | -- | 50 | 48 | -- | 71 |
| U.K. | 51 | 20 | 100 | -- | -- | 64 | 30 | -- | 35 |
| BELGIUM | 79 | 53 | 23 | -- | -- | 42 | 26 | -- | 53 |
| FRANCE | 70 | 53 | 100 | -- | -- | 17 | 48 | -- | 41 |
| GERMANY | 84 | 55 | 54 | -- | -- | 45 | 39 | -- | 71 |
| ITALY | 74 | 58 | 100 | -- | -- | 73 | 52 | -- | 71 |
| NETHERLANDS | 74 | 45 | 54 | -- | -- | 45 | 39 | -- | 53 |
| SWITZERLAND | 63 | 60 | 31 | -- | -- | 57 | 39 | -- | 53 |
| JAPAN | 47 | 53 | 62 | -- | -- | 60 | -- | -- | 76 |
| SAMPLE SIZE | 43 | 40 | 13 | -- | -- | 22* | 23 | -- | 17 |
| ALL CURRENCY % | 64 | 43 | 60 | -- | -- | 50 | 40 | -- | 52 |
| SAMPLE SIZE | 307 | 360 | 117 | --- | --- | 197 | 184 | --- | 153 |

### HORIZON 12 MONTHS

| CURRENCY | SERVICE => 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| CANADA | 29 | 62 | 8 | -- | -- | 47 | 11 | -- | 82 |
| U.K. | 62 | 24 | 92 | -- | -- | 50 | 21 | -- | 18 |
| BELGIUM | 94 | 59 | 33 | -- | -- | 5 | 86 | -- | 41 |
| FRANCE | 88 | 49 | 100 | -- | -- | 40 | 32 | -- | 29 |
| GERMANY | 94 | 54 | 33 | -- | -- | 30 | 11 | -- | 35 |
| ITALY | 100 | 54 | 100 | -- | -- | 68 | 58 | -- | 76 |
| NETHERLANDS | 94 | 51 | 67 | -- | -- | 21 | 26 | -- | 41 |
| SWITZERLAND | 71 | 35 | 42 | -- | -- | 44 | 15 | -- | 35 |
| JAPAN | 56 | 30 | 50 | -- | -- | 65 | -- | -- | 65 |
| SAMPLE SIZE | 34 | 37 | 12 | -- | -- | 20* | 19 | -- | 17 |
| ALL CURRENCY % | 76 | 41 | 58 | -- | -- | 40 | 24 | -- | 47 |
| SAMPLE SIZE | 306 | 333 | 108 | --- | --- | 197 | 152 | --- | 153 |

## TABLE 6: PROBABILITY ($p_1$) OF OBSERVING AS GOOD OR SUPERIOR TRACK RECORD UNDER THE NULL HYPOTHESIS (INDEPENDENT SAMPLES)

### HORIZON 1 MONTH

| CURRENCY | SERVICE => 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| CANADA | 99 | 17 | 99 | -- | -- | 19 | 21 | -- | 17 |
| U.K. | 56 | 94 | 1 | -- | -- | 10 | 57 | -- | 83 |
| BELGIUM | 1 | 26 | 95 | -- | -- | 11 | 34 | -- | 50 |
| FRANCE | 23 | 35 | 13 | -- | -- | 79 | 34 | -- | 83 |
| GERMANY | 5 | 83 | 71 | -- | -- | 4 | 34 | -- | 17 |
| ITALY | 3 | 26 | 1 | -- | -- | 2 | 66 | -- | 7 |
| NETHERLANDS | 1 | 62 | 50 | -- | -- | 33 | 66 | -- | 3 |
| SWITZERLAND | 77 | 35 | 97 | -- | -- | 59 | 89 | -- | 50 |
| JAPAN | 56 | 50 | 71 | -- | -- | 33 | -- | -- | 3 |
| SAMPLE SIZE | 45 | 14 | 13 | -- | -- | 22* | 24 | -- | 17 |
| ALL CURRENCY % | 2 | 50 | 15 | -- | -- | 1 | 72 | -- | 1 |
| SAMPLE SIZE | 405 | 126 | 117 | --- | --- | 197 | 192 | --- | 153 |

### HORIZON 6 MONTHS

| CURRENCY | SERVICE => 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| CANADA | 100 | 50 | 100 | -- | -- | 69 | 69 | -- | 12 |
| U.K. | 23 | 94 | 12 | -- | -- | 69 | 31 | -- | 87 |
| BELGIUM | 23 | 77 | 87 | -- | -- | 94 | 100 | -- | 50 |
| FRANCE | 6 | 77 | 12 | -- | -- | 94 | 69 | -- | 87 |
| GERMANY | 6 | 77 | 50 | -- | -- | 100 | 100 | -- | 12 |
| ITALY | 1 | 50 | 50 | -- | -- | 69 | 94 | -- | 12 |
| NETHERLANDS | 6 | 50 | 87 | -- | -- | 94 | 94 | -- | 87 |
| SWITZERLAND | 1 | 23 | 100 | -- | -- | 94 | 69 | -- | 50 |
| JAPAN | 94 | 50 | 87 | -- | -- | 69 | -- | -- | 12 |
| SAMPLE SIZE | 7 | 7 | 3 | - | - | 4 | 4 | - | 3 |
| ALL CURRENCY % | 2 | 45 | 58 | -- | -- | 98 | 96 | -- | 2 |
| SAMPLE SIZE | 63 | 63 | 27 | -- | -- | 36 | 32 | -- | 27 |

### HORIZON 3 MONTHS

| CURRENCY | SERVICE => 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| CANADA | 94 | 79 | 97 | -- | -- | 73 | 86 | -- | 34 |
| U.K. | 30 | 99 | 3 | -- | -- | 6 | 64 | -- | 11 |
| BELGIUM | 15 | 79 | 91 | -- | -- | 93 | 86 | -- | 34 |
| FRANCE | 15 | 21 | 3 | -- | -- | 93 | 86 | -- | 89 |
| GERMANY | 5 | 60 | 50 | -- | -- | 50 | 96 | -- | 34 |
| ITALY | 3 | 60 | 3 | -- | -- | 6 | 36 | -- | 11 |
| NETHERLANDS | 1 | 91 | 50 | -- | -- | 73 | 86 | -- | 34 |
| SWITZERLAND | 77 | 60 | 91 | -- | -- | 50 | 36 | -- | 11 |
| JAPAN | 56 | 21 | 91 | -- | -- | 23 | -- | -- | 11 |
| SAMPLE SIZE | 15 | 14 | 5 | -- | -- | 8* | 8 | -- | 6 |
| ALL CURRENCY % | 2 | 76 | 5 | -- | -- | 45 | 84 | -- | 1 |
| SAMPLE SIZE | 135 | 126 | 45 | -- | -- | 69 | 64 | -- | 54 |

### HORIZON 12 MONTHS

| CURRENCY | SERVICE => 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| CANADA | 50 | 6 | -- | -- | -- | -- | -- | -- | -- |
| U.K. | 87 | 69 | -- | -- | -- | -- | -- | -- | -- |
| BELGIUM | 50 | 69 | -- | -- | -- | -- | -- | -- | -- |
| FRANCE | 50 | 69 | -- | -- | -- | -- | -- | -- | -- |
| GERMANY | 12 | 94 | -- | -- | -- | -- | -- | -- | -- |
| ITALY | 12 | 69 | -- | -- | -- | -- | -- | -- | -- |
| NETHERLANDS | 12 | 94 | -- | -- | -- | -- | -- | -- | -- |
| SWITZERLAND | 50 | 69 | -- | -- | -- | -- | -- | -- | -- |
| JAPAN | 50 | 94 | -- | -- | -- | -- | -- | -- | -- |
| SAMPLE SIZE | 3 | 4 | 1 | - | - | 2 | 2 | - | 2 |
| ALL CURRENCY % | 1 | 63 | -- | -- | -- | -- | -- | -- | -- |
| SAMPLE SIZE | 27 | 36 | -- | -- | -- | -- | -- | -- | -- |

## FOOTNOTES

[1]In the case where risk neutral firms can trade forward exchange contracts at a price equal to the expected future spot rate, Baron (1976) demonstrates that there is no welfare loss from exchange rate uncertainty. Consequently, in our example, the owners of information will receive an income transfer from the rest of the world. (The forward market is a zero sum game). However, if investors are risk averse, the production of accurate information should reduce uncertainty about future relative prices. Increased trade in goods and capital results in an increase in world income.

[2]A highly informative and readable survey of foreign exchange advisory services is in Euromoney, August 1978.

[3]The importance of prediction is stressed by Friedman (1953) who states "the only relevant test of the validity of a hypothesis is comparison of its predictions with experience." With respect to econometric prediction, Christ (1951) makes the stronger statement that "The ultimate test of an econometric model... comes with checking its predictions."

[4]Two earlier papers have reported on the accuracy of advisory service forecasts. King (1978) aggregated forecasts across advisory services to form a simple average "professional" forecast. During the seven quarter period 1976-I to 1977-III, the professional forecast was superior to the forward rate forecast only for the DM. King suggested that this is a surprising result since the DM market is very active and speculators should act so that the information in the forecast is quickly reflected in the forward rate. An alternative explanation, which we consider further in section II, is that speculators are risk averse and as a result the forward rate is not necessarily the best publicly available forecast.

Goodman (1979) analyzed both medium-term, economic oriented advisory services and short-term technical advisory services. While the former group appeared no more accurate than the forward rate, Goodman concluded that the technical services could lead to large profits following a daily trading strategy. "(The technically-oriented services') consistently very strong predictive performance supports the view that speculative runs do occur in the exchange market and that the foreign exchange market is not efficient."

[5]See, for example, Fama (1970) and Black (1971).

[6]This is essentially a restatement of the semistrong form tests of asset market efficiency which posits that prices reflect publicly available information. One straightforward test of this hypothesis is reported in Scholes (1972).

[7]One important study in this regard was by Jensen (1968) who concluded that professionally managed mutual funds did not in general achieve unusual returns relative to the risk and management costs incurred. The general decline in stock market prices (in real terms) over this period also helped to tarnish the image of professionalism and expertise.

[8]These assumptions include continuous trading, no transaction costs and no information costs. The efficient market hypothesis does allow for heterogeneous expectations, but the algebraic formulation and empirical testing of a model with heterogeneous expectations is considerably more complex.

[9]We should note that we are considering information purchases only for the purpose of "picking winners or beating the market." Investors who do not wish to do this will still require some information to match a portfolio to their risk preferences.

[10]As a theoretical matter, even this latter case requires further qualification. Other investors may imitate the trader with expertise and in doing so lower his profits. Alternatively, traders without expertise may lose over time and leave the market so that the trader with expertise comes to dominate and become the market.

[11]For a detailed discussion of these issues, see Raiffa and Schaifer (1968), especially Chapter 6.

[12]If $p < 0.5$, the advisory service has no expertise. But in this case, investors can simply reverse the advisory service recommendations.

[13]At the Chicago Mercantile Exchange, interest earning U.S. Treasury bills are acceptable to meet margin requirements.

[14]If the investor owns a U.S. dollar asset, he must sell it and give up return $i_{\$}$.

[15]Dooley and Shafer (1976) recognize this point in their analysis.

[16]The "Modern Theory" approach popularized by Grubel (1966) presents a partial equilibrium model. Speculators are assumed to be risk averse although there is no operational model for estimating the foreign exchange risk premium.

More recent papers by Roll and Solnik (1977) and Grauer,

Litzenberger, and Stehle (1976) present a general equilibrium framework, but there is disagreement about how, or if, these models can be made operational. See the discussion in the Journal of Finance, May 1977.

[17]As in our earlier test for forecasting expertise, we must a assume the probability of correct prediction is constant over time. In addition, however, we must assume that the distribution of speculative returns is constant over time. When this assumption is not met, the H-statistic can give misleading results. For example, suppose a forecasting service provides incorrect forecasts in nine consecutive preiods, however in each period the loss is sma-1 ($.01 per contract). Assume further that in period ten the service correctly predicts a large exchange rate change ($.41). Judging by the H-statistic (H = $.52 actual profit / $.50 potential profit = 64%), the advisory service is doing an admirable job. However, the probability of correct advise in any single period is low (p = r/n = 0.10) and significantly worse than guessing.

[18]The problem of selecting an historical set of spot rates to represent the market price brings into focus the issue of selecting a reasonable standard for assessing forecasting accuracy. We have observed that exchange rates sometimes trade within a 1% or 2% daily range; recently for the Swiss franc and the Japanese yen, the range has a-proached 4%-5%. For example, on January 1 at 9:00 a.m., the three-month forward rate may be $2.00. On April 1 at 9:00 a.m. the spot rate may by $2.00 and then proceed to close at $2.06. Is this a 3% forecast error even if the trader could have sold his

position during the day at a favorable rate? For this observation, the selection of an opening rate, a noon rate or a closing rate has a great impact on the forecast error. We can add that at any moment of time, foreign exchange rates also may vary somewhat across the world's many trading rooms.

[19]Since the forecast frequency is generally one observation per month, the one-month panel also represents an independent sample.

[20]We use the exact binomial calculation for samples smaller than 18, and the normal approximation otherwise.

## REFERENCES


Baron, D.P. "Flexible Exchange Rates, Forward Markets and the Level of Trade." American Economic Review 66, No. 3 (June 1976): 253-66.

Bilson, John F.O. and Levich, Richard M. "A Test of the Forecasting Efficiency of the Forward Exchange Rate." New York University No. 77-61, June 1977.

Black, Fischer. "Implications of the Random Walk Hypothesis for Portfolio Management." Financial Analysts Journal (March/April 1971): 16-22.

Christ, Carl F. "A Test of an Econometric Model for the United States, 1921-47." In Conference on Business Cycles. New York: National Bureau of Economic Research, 1951.

Cornell, Bradford. "Spot Rates, Forward Rates and Exchange Market Efficiency." Journal of Financial Economics 5 (August 1977): 55-65.

Dooley, Michael P. and Shafer, Jeffrey R. "Analysis of Short-Run Exchange Rate Behavior: March, 1973 to September, 1975." International Finance Discussion Papers, No. 76. Washington, D.C.: Federal Reserve System, February 1976.

Fama, Eugene F. "Efficient Capital Markets: A Review of Theory and Empirical Work." Journal of Finance 25, No. 2 (May 1970): 383-417.

Figlewski, Stephen. "Market 'Efficiency' in a Market with Heterogeneous Information." Journal of Political Economy 86, No. 4 (August 1978): 581-97.

Figlewski, Stephen. "Investor Diversity and Market Behavior." New York University, Salomon Brothers Center Working Paper No. 141, April 1978.

Friedman, Milton. Essays in Positive Economics. Chicago: University of Chicago Press, 1953.

Goodman, Stephen H. "Foreign Exchange Rate Forecasting Techniques: Implications for Business and Policy. Journal of Finance 34, No. 2 (May 1979): forthcoming.

Grossman, Sanford J. and Joseph E. Stiglitz. "Information and Competitive Price Systems." American Economic Review 66, No. 2 (May 1976): 246-53.

Jaffe, Jeffrey F. "Special Information and Insider Trading." Journal of Business 47, No. 3 (July 1974): 410-28.

Jensen, Michael. "The Performance of Mutual Funds in the Period 1945-64." Journal of Finance 23 No. 2 (May 1968): 389-416.

King, David T., "Exchange Market Efficiency and the Risk Taker of Last Resort." Mimeographed, OECD and Federal Reserve Bank of New York, July 1978.

Levich, Richard M. "The International Money Market: Tests of Forecasting Models and Market Efficiency." Unpublished Ph.D. Dissertation, University of Chicago, 1977.

Levich, Richard M. "Further Results on the Efficiency of Markets for Foreign Exchange." Federal Reserve Bank of Boston, Conference Series No. 20, 1978.

Lloyd-Davies, Peter, and Canes, Michael. "Stock Prices and the Publication of Second-Hand Information." Journal of Business 51, No. 1 (January 1978): 43-56.

Lorie, James H. and Niederhoffer, Victor. "Predictive and Statistical Properties of Insider Trading." Journal of Law and Economics 11, No. 2 (April 1968): 35-51.

Makin, John H. "Portfolio Theory and the Problem of Foreign Exchange Risk." Journal of Finance 33, No. 2(May 1978):517-34.

McDonald, John. "French Mutual Fund Performance: Evaluation of Internationally Diversified Portfolios." Journal of Finance 28, No. 5 (December 1973): 1161-80.

Raiffa, Howard and Schlaifer, Robert. Applied Statistical Decision Theory. Cambridge: M.I.T. Press, 1968.

Roll, Richard and Solnik, Bruno. "A Pure Foreign Exchange Asset Pricing Model." Journal of International Economics 7, No. 2 (May 1977): 161-179.

Scholes,Myron S. "The Market for Securities: Substitution versus Price Pressure and the Effects of Information on Share Prices." Journal of Business 45, No. 2 (April 1972): 179-211.

Tsiang, S.C. "The Theory of Forward Exchange and the Effects of Government Intervention on the Forward Market." Staff Papers 7, No. 1 (April 1959): 75-106.