

**EVALUATING PROBABILISTIC FORECASTING
ACCURACY OF EXCHANGE RATES**

M. B.A. THESIS

By
ŞULE ÖZTİN
January, 1996

THESIS
HG
3851
.098
1996

HG
3851
098
1996

B053826

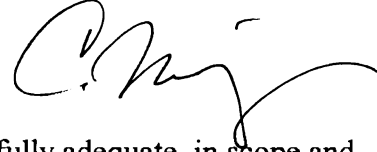
I certify that I have read this thesis and in my opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Business Administration.



Assoc. Prof. Dilek ÖNKAL

I certify that I have read this thesis and in my opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Business Administration.

Assist. Prof. Can Şimşak MUĞAN



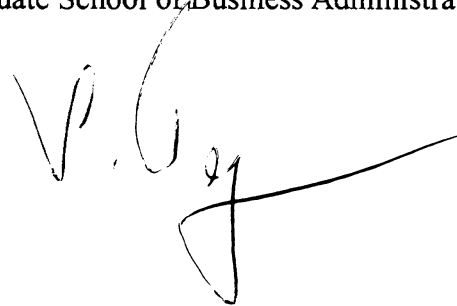
I certify that I have read this thesis and in my opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Business Administration.



Assist. Prof. Ayşe YÜCE

Approved for the Graduate School of Business Administration

Prof. Sübidey TOGAN



ABSTRACT

EVALUATING PROBABILISTIC FORECASTING ACCURACY OF EXCHANGE RATES

ŞULE ÖZTİN

Master of Business Administration

Supervisor: Assoc. Prof. Dilek ÖNKAL

January 1996, 41 pages

This study aims to explore various dimensions of probabilistic forecasting accuracy. In particular, the effects of using dichotomous format on the performance of semi-experts' and novices' probabilistic forecasts of exchange rates and currencies are examined. Semi-experts are comprised of banking and finance professionals in the finance sector. Novice group consists of MBA students from the Faculty of Business Administration at Bilkent University. The results suggest that the dichotomous format used to elicit the probabilistic forecasts has a differential effect on the performance of semi-experts and novices. Implications of these findings for financial forecasting are discussed and directions for future research are given.

Key words: probability forecasting, exchange rate, currency forecasting

ÖZET

DÖVİZ KURLARININ OLASILIKSAL TAHMİNLERİNİN DEĞERLENDİRİLMESİ

ŞULE ÖZTİN

Yüksek Lisans Tezi, İşletme Enstitüsü

Tez Yöneticisi: Doç. Dr. Dilek ÖNKAL

Ocak 1996, 41 sayfa

Bu çalışma olasılıksal tahminlerin incelenmesini amaçlamaktadır. Bu bağlamda, iki sonuçlu format kullanılarak, yarı uzman ve uzman olmayan grupların döviz kurları ve pariteleri ile ilgili olasılıksal tahmin performansları incelenmiştir. Sonuçlar, yarı uzman ve uzman olmayan grupların olasılıksal tahminlerini tayin etmek için kullanılan iki sonuçlu formatın, grupların performansları üzerinde farklı etkileri olduğunu göstermiştir. Finansal tahminlerle ilgili sonuçlar tartışılmış ve gelecek çalışmalar için konular önerilmiştir.

Anahtar kelimeler: olasılıksal tahmin, döviz paritesi, kur tahmini

ACKNOWLEDGEMENT

This thesis has benefited greatly from the supervision and the contribution of the Assoc. Prof. Dilek Önköl and other thesis examination committee members.

I am grateful to my colleagues for their constructive supports and their participation during the preparation of this study. Also I am indebted to all the participants for their corporation and help throughout the study.

I owe special thanks to Haludun Leventoglu for his support and help ,and to my mother for her life time support and encouragement.

TABLE OF CONTENTS

ABSTRACT.....	iii
ÖZET	iv
ACKNOWLEDGEMENTS	v
LIST OF TABLES	vii
1. INTRODUCTION.....	1
1.1. Types of Exchange Rates.....	1
1.2. Impact of Foreign Exchange on Financial Management.....	3
1.2.1. The Balance Sheet	4
1.2.2. Profit and Loss	5
1.2.3. Cash Flows	5
1.3. Factors Influencing Forecasting Exchange Rates.....	6
1.3.1. The Role of International Monetary System	6
1.3.2. The Balance of Payments	7
1.3.3. Government Economic Policy.....	7
1.3.4. Technical and Psychological Factors	9
1.4. Studies on Exchange Rates.....	10
1.4.1. Group I : Studies on Time Frame and Techniques.....	10
1.4.2 . Group II: Studies of the Turkish Case.....	18
1.4.3. Group III : Other Studies.....	19
2. PROCEDURE.....	22
3. PERFORMANCE MEASURES USED	26
3.1. Mean Probability Score	26
3.2. Calibration	27
3.3. Scatter	27
3.4. Slope	28
3.5. Bias--Over/underconfidence	28
4. FINDINGS	30
5. CONCLUSION	32
REFERENCES	39

LIST OF TABLES

1. Median, mean, standard deviation, minimum and maximum values for the performance measures of semi-experts.....	36
2. Median, mean, standard deviation, minimum and maximum values for the performance measures of novices	37
3. Comparisons of performance measures for dichotomous forecasts of semi-experts and novices	38

1. INTRODUCTION

Exchange rate is the price at which a particular currency can be bought or sold in terms of another currency. This price can be the result of supply and demand for the currency in the open, unrestricted market, or at other extreme, firmly fixed by edict of a government or its monetary authority, usually the central bank. "But, most of the time, the value of currencies is decided by the interaction of the free market forces playing their role, alleviated by the intervention of the monetary authorities to ensure their currencies do not depreciate or appreciate excessively" (Coninx, 1986, pp. 1).

1.1. Types of Exchange Rates

-Direct Quotations: In most countries the internal exchange rates are expressed in units of the national currency. This is the so-called direct quotation system. For instance , in West Germany one US dollar will be worth x units of Deutsche Mark and in New York one Deutsche Mark will be worth y cents. Lately there has been a tendency among the professional traders in the US foreign exchange market to deal on an indirect basis outside the world and themselves.

- Indirect Quotation: UK is one of the few places applying the indirect quotation system. As mentioned before, New York is another centre which finds it preferable to adopt a system valuing the national unit of account rather than the foreign one. In London, US dollar will be quoted as x units dollars worth one pound sterling. In other words, the

indirect quotation system values the pound or the dollar in terms of other currencies (even when they are home currencies). But whatever system is employed, when two cross border interests wish to transact foreign currency business, one of them will have to apply an indirect quotation when dealing with each other's currencies.

- Cross Rates : An exchange rate is called a cross rate when the national currency is not party to the transaction. A London bank buying or selling Deutsche Marks against US dollars is obviously using cross rate . For dealings in the international market, cross rates with US dollars are often used, as the US dollar is not only the world's main reserve currency, but also provides the base currency for most exchange transactions.

- Forward Rates: While the exchange rate is also the spot rate for the currency and the numeraire for the national currency, the forward rate is sometimes looked as the true indicator of what the value a currency should have at a particular time in the future. Or at least, the forward rate should provide strong indication of the direction of a future exchange rate. It is doubtful, however, whether the trend or the future are clearly defined in a forward rate. Mostly, forward rates show the interest differentials operative in the countries of the currencies involved in an exchange operation.

It must be noted, though, that forward rates are of more value to the commercial users of the market than the spot rates. The forward rates are the true indicators of what prices are appropriate for imports and exports of the services and goods, in view of the time-lag between negotiation, execution and delivery (Coninx,1986) .

1.2. Impact of Foreign Exchange on Financial Management

Foreign exchange has an effect on the environment and attitude of a company. The need to transact, deal and think in a variety of different languages and currencies- that is foreign exchange- is an important aspect for the companies. However, the requirement to think and plan in a variety of currencies gives the possibility of extraneous gains and the losses and the need to manage risks and the opportunities associated with this additional dimension (Mapletuft, 1991).

The corporate culture is affected by foreign exchange in a variety of ways, ranging from the trivial requirement to travel and appreciate the risk of currency conversion, to the important need to price in local currency and compete internationally. Among the diverse aspects of the company that are affected by foreign exchange are(Mapletuft, 1991):

1. sales in currencies, with need to transact , record, and move funds;
2. selling organisations located abroad, often in local subsidiary companies, implying the need for:
 - (a) international sales and marketing management, enabling the company to appreciate the impact of foreign competition on those markets;
 - (b) purchase in foreign currency, clearly a requirement even for completely domestic companies, but providing a rationale for:
 - exchange management, in terms of the purchase of currency from sales, and the management of the net exposures,

- treasury strategy, involving the establishment of the company's philosophy and approach to exchange risk.

The impact of foreign exchange can be seen particularly on the treasury items within the balance sheets and profits and loss accounts and cash flows (Mapletuft, 1991).

1.2.1. The Balance Sheet

Evidence of the influence of foreign exchange can be seen in an examination of the balance sheet. Firstly, the denomination of assets of the company, structurally where to locate centres or production and distribution, including stocking points, is a decision as much linked to the long term views on comparative long-term economics of manufacture and competition as to exchange rates per se, but requires similar thinking on the assets of the preference and their management.

Secondly, the structure of liabilities side of the balance sheet can be affected by the currency considerations. The decision equity listing is linked to the availability of international capital, and to the desire of companies to ensure to adequate the availability of their stock, liquidity and the share price support. Currency borrowing is a business-related decision and also one determined by central strategy. This incorporates not only borrowing for business requirements, where often local loans are efficient to achieve maximum deductibility, but centralised and strategic borrowing where the choice of currency and the location of debt are interlinked decisions.

Thirdly, short term asset management is an area in which there are structural considerations of a foreign exchange nature, a part from the hedging and off balance sheet obligations that will be a significant consideration elsewhere.

1.2.2. Profit and Loss

Influences of foreign exchange decisions are evident in an examination of profit and loss account. Firstly, the conversion of foreign exchange currency dominated receipts and payments is the major variable against which hedging actions are often recommended.

Secondly, translation of overseas subsidiaries' local profits to the home currency, which is sometimes regarded as outside the control of the central treasury since no cash flows are made for this variable until dividend payments are made.

Thirdly, currency movements on short term assets and liabilities are revalued into the profit and loss account at accounting period end, rather than into reserves, which is the treatment for the long term balance sheet items.

1.2.3. Cash Flows

The cash flow of the company must clearly exhibit the impact of foreign exchange decisions on financial operations of the company. Business related foreign exchange cash flow items are, clearly, the supplies of the imported raw materials and the machinery and the export of finished product, their timing and pricing terms and conditions. Other financial flows include interest payments on loans and deposits and dividend flows in currency.

The act of dealing with foreign exchange rates is assumed to have an important role in effective financial management. Hence, besides knowing the spot values of foreign exchange rates, it is important for the companies to know the future values of exchange rates as they are planning to survive at the market in the long run.

1.3. Factors Influencing Forecasting Exchange Rates

Foreign exchange markets shift in their attitudes towards economic and market influences. In examining the exchange rate behaviour, some fundamental factors have to be considered. These include, the international monetary system, the balance of payments and the government policy. But technical and psychological factors are also important inputs to the forecasting process (Bell and Kettel, 1983).

1.3.1. The Role of International Monetary System

Forecasting of exchange rates consists essentially of a three- step procedure. First, from an examination of the country's balance of payments' trends and other fundamentals, particularly relative rates of inflation, a measure of the pressure on a currency is obtained. Second, changes in the level of foreign exchange reserves of the central bank are used to indicate when a situation might become critical. Finally, there is the crucial step of predicting which of the rather limited policy options the economic decision makers of a nation will resort to in a crisis. The success or failure of the forecasting game depends on the final step. The difficulty is eased by the fact that those who decides on devaluation's and revaluations are, unlike private transactors, not guided by profit maximising objectives.

“ The motives of monetary authorities comprise the full spectrum from the national prestige and domestic partisan politics to fears of post- devaluation inflationary pressures and post-revaluation unemployment” (Bell and Kettel, 1983, pp. 154-155).

1.3.2. The Balance of Payments

Exchange of goods is recorded by visible trade account, the exchange of services (including payment of interest, profits and dividends) by the invisible trade account and the exchange of capital by the capital account. The first two items combined are known as the current account. These flows represent the demand and the supply for a currency, and therefore determine the exchange rate.

“Forecasting bureaux frequently make exchange rate projections with reference to these flows themselves. One advantage of this approach is that it enables them to take into account direct information about the balance of payments, for example the effects of major strike etc.” (Bell and Kettell, 1983). The current account is worth considering in a forecast both its direct effect on exchange rate and for its indirect effect on exchange market expectations. While a current account surplus causes some operators (e.g. importers) to buy a currency, the rate at which others will be willing to satisfy this demand by selling the currency in question depends, among other things, on their view of the future direction of the current account. If the surplus is expected to rise, existing holders will probably be unwilling to sell unless they are offered a higher rate. It is therefore the trend rather than the level of current account which needs to be captured in an exchange rate forecast.

1.3.3. Government Economic Policy

Governments have many objectives. These include increasing the growth rate of economy, full employment, price stability and improving the balance of payments. The table summarises the effect of government policies on exchange rates.

Problem	Prescription to attack problem	Impacts on other economic objectives	Impact on exchange rate
1. High unemployment	Expansionary monetary and fiscal policy	Price levels: inflationary trends External balance: deterioration imports increase, capital outflow	Downward pressure
2. High inflation	Contradictory monetary and fiscal policy	Employment tendency to decrease as aggregate demand declines External balance: improvement imports decrease, capital inflow	Upward pressure
3. Balance of payment deficit	Contradictory monetary and fiscal policy	Employment tendency to decrease as aggregate demand declines Inflation: tendency to decrease as aggregate demand declines	Upward pressure
4. Balance of payments surplus	Expansionary monetary and fiscal policy	Employment: tendency to increase as aggregate demand increases Inflation: tendency to increase as aggregate demand increases	Downward pressure

Source: Bell and Kettell, "Foreign Exchange Handbook", (1983), pp.158.

Changes in macroeconomic policy tend to have an immediate impact on the exchange rate via the expectation that they will affect the balance of payments.

1.3.4. Technical and Psychological Factors

Operators in the market are very sensitive to short term psychological and technical reactions which may distort the basic longer -term trend of exchange rates. Expectations have a crucial role to play in the exchange rate determination. Whenever there is a discrepancy between the previously held expectation of a given economic event and the actual outcome of that event, exchange rates are usually affected. As already argued, a trade account surplus causes pressure towards an exchange rate appreciation. However, if the actual reported surplus turns out to be less than the expected outcome , this may cause downward pressure on a currency.

Technical factors can also affect exchange rates. Some currencies tend to move together. Examples of this is the Swiss franc and the Australian schilling which tend to move with Deutsche Mark. Thus market operators know that if one currency rises in value, then in order to maintain the relationship the other currency will flow to suit. Thus a rise in the dollar/Swiss franc rate will be accompanied by the rise in the dollar/deutsche mark rate or vice versa. Another technical factor is that some currencies are used as world reserve currencies. These currencies are held as a store of value as well a medium of exchange. Participants in the foreign exchange market who hold, for example, the dollar as a store value may react very nervously to expectations that in the short run the dollar is expected to fall while in the medium term the fundamentals are in the dollar favour.

1.4. Studies on Exchange Rates

Studies on foreign exchange rates are grouped into three categories where the first group includes studies about the techniques used in forecasting of exchange rates and studies depending on time frame. The second group includes the studies about the exchange rates in the Turkish case and the third group includes studies about the effects of exchange rates on operating profit, inflation, interest rate differentiation, and exports; and other studies related to the exchange rate expectations chronologically.

1.4.1. Group I : Studies on Time Frame and Techniques

Friedman and Vandersteel (1982) examine the statistical properties of daily changes in foreign exchange rates for nine currencies and found that these changes are leptokurtotic, i.e. have long tailed and sharp peaked histograms. The evidence suggest that this leptokurtosis does not arise from an underlying Paratian stable distribution, nor from a stationary mixture of normal distributions but rather from normal processes with time varying parameters. Their finding casts doubt on the validity of many standard techniques (t-stats, ARIMA methods).

Fama (1984) tests a model for joint measurement of variation in the premium and the expected future spot rate components of forward rates. There is a general consensus that a forward rate have a little if any power as forecasts of future exchange rates. Conditional on the hypothesis, that the forward market is efficient or rational, there exist reliable evidence that both components of forward rates vary on time. Conclusions are (a) most of the variation in forward rate is variation in premiums, (b) the premium and the expected future spot rate components of forward rates are negatively correlated.

Hogan (1986) compares a number of structural and time series models on the basis of their accuracy in forecasting the Australian US dollar rate over the period December quarter 1974 to June quarter 1984, thus covering a period of varying bilateral exchange rate regimes. Purchasing Power Parity, forward exchange theory, static and dynamic specifications of both the flexible price and sticky price monetary models and univariate ARIMA models are considered in the paper. Exchange rate forecasts are generated at horizons of one to four quarters. In contrast to the overseas results which support the view that the exchange rate follows a random walk, several models in the study are found to generate forecasts superior to the random walk model.

Khoury (1986) reviews the pitfalls and the merits of existing approaches to forecasting exchange rates and introduces a new element in the forecasting model; the stability predictors; a potent element for predicting whether or not a currency will appreciate or depreciate on a month to month basis. The findings are that the stability variables do improve the forecasting ability of an econometrically based model. The results of the suggested model are superior to those derived using the forward rate and the current spot rate as forecasting tools for future spot rates.

Wadhwani (1987) applies standard variance tests to assess whether the Dornbusch overshooting model can explain the volatility of exchange rates. He found that exchange rates are too volatile to be consistent with the Dornbusch (1976) overshooting model and/or an efficient market. The violation of some of the inequalities is consistent with the hypothesis that the exchange rates are excessively volatile.

Kim (1987) studies the random walk behaviour of nominal exchange rates using daily, weekly and monthly data of real exchange rates using monthly data is investigated for seven major currencies. It has been found that random walk hypothesis is decisively

rejected for daily and weekly nominal exchange rates, while it is much less rejected in the case of monthly nominal exchange rates. Similar results obtained for monthly real exchange rates. The random walk behaviour in the late 1970s, is also investigated and is much frequently accepted.

Wolff (1988) performs an ex-post forecasting experiment on the basis of a version of the “news” model of exchange rate determination. He addresses that the exchange rates are highly sensitive assets prices which are immediately affected by an influx of new information. This approach is generally taken into imply that empirical research on the determinants of exchange rates should relate innovations in a relevant vector of explanatory models. For a majority of the exchange rates studied, however, the results do not compare favourably with these obtained from the naive random walk forecasting rule. Thus, findings in the article provide mixed evidence with regard to a suggestion in the literature that the findings by Meese and Rogoff that the structural models do not even outperform the random walk in an ex-post forecasting experiment, may be due to the fact that these models were not properly tested in a “news “ framework.

Hsieh (1988) examines the statistical properties of daily rates of change of the prices of five foreign currencies from 1974-1983. The main purpose is to discriminate between two competing explanations for the observed heavy-tails of the distributions; that the data are indepently drawn from a heavy tail distribution which remains fixed over time and the data come from distributions which vary over time. His findings are; (a) exchange rates are not independent and identically distributed, (b) each day of the week may have a different distribution, but is not sufficient to explain the rejection of independent and identically distributed , (c) there is a little correlation in the data , (d) means and variances change over

time. He also mentioned that time varying means and variances are not sufficient to fully account for the leptokurtosis in the exchange rate changes.

Kling and Bessler (1989) study some techniques of probability forecasting time series data on interest rates, money stock, consumer prices and output. The paper reviews the concepts of prequential data analysis as proposed by Dawid and discuss some procedures for evaluating probability forecasts. Further, they demonstrate and apply a sequential method for recalibrating predictive distributions based on previously issued distributions and outcomes and test their estimated sequences of unadjusted and recalibrated distributions for calibration. Their results are encouraging in that the calibration hypothesis can not be rejected for most of the time series and forecast horizons when the recalibration procedure is applied. Furthermore traditional point forecasts can be improved (in a mean-squared error sense) when the forecasts are derived from recalibrated distributions. The calibration test suggests that a nonconstant variance assumption is probably necessary if predictive intervals are to capture the realisation of the time series the proper proportion of times.

Guerard, JR. (1989) examines the time series of process exchange rates and used the time series forecasts as inputs to foreign exchange composite models with forward rates and bank forecasts. It has been shown that the high degree of correlation among bank, time series and forward price forecasts of foreign exchange rates provides an excellent example for biased regression results. When forecasting short and medium term exchange rate movements, the forward rate is superior to composite modelling. Thus the short and medium term currency markets are efficient. However, although reasonable estimation models need not imply good post-sample forecasting results, the ridge regression weighted and equally weighted forecasts performed well in the long term exchange rate forecasting.

Khodly and Sohrabian (1990) study whether an identifiable casual relationship exists between the exchange rates and prices for the major US trading partners. The period investigated extends from July 1973 to September 1988. The paper employs the Granger Direct test to test the null hypothesis of a lack causality from prices to exchange rates. Two measures of inflation are considered and included percentage changes in consumer prices and wholesale prices. The results of the tests showed a significant casual relationship from the wholesale prices to changes in exchange rates, but not to consumer prices. The inferences from the test of causality between the exchange rates and the wholesale prices implies that the proper specification of empirical tests of PPP is not the single equation method that views prices as causing the exchange rates.

Baillie and Bollerslev (1990) consider the detailed relationship between the return and the volatility of four major floating foreign exchange rates vis-à-vis the US dollar ; on a hourly basis as they are quoted on the different currency markets around the world. A seasonal GARCH model is developed to describe the time dependent volatility apparent in the percentage nominal return of each currency. Hourly patterns in volatility are found to be similarly across the currencies and appear to be related to the opening and the closing of the world's major market. Robust LM test designed to deal with the extreme leptokortusis in the data fails to uncover any evidence of misspecification or the presence of volatility split over effects between the currencies or across the markets.

Gerlow and Irwin (1991) study the general regression test that accounts for market timing to four forecasting models both the Canadian dollar/US dollar and the West German Mark/US dollar over the period 1976/November- 1984/August. Of these models , only the unconstrained static and dynamic forecasting models exhibited significant market timing value with respect to Canadian dollar and then only over a month time horizon. The

constrained dynamic model has a market timing ability at three month time horizon under Decision Rule 1. With respect to West German Mark, the constrained static forecasting model showed market timing ability at both the three and six month forecast horizon under both decision rules. The static unconstrained model has a market ability in forecasting the West German Mark over a three month horizon under Decision Rule 1. The results suggest that the monetary /asset models have economically valuable forecasting ability over limited forecast horizons.

Lai and Pauly (1992) reports out-of-sample forecasting experiments which evaluated the predictive ability of the bandwagon expectations model for weekly spot exchange rates over the 1980-1986 period. The empirical results based on five major currencies generally suggest the presence of significant bandwagon effects in the actual rate dynamics. The writers concludes that the bandwagon forecasting scheme can improve the forecasting accuracy in terms of both mean squared errors and market timing upon the random walk and VAR models.

Nachane and Ray (1993) study the dynamics of foreign exchange rate with new frequency domain techniques. Stationary properties of the rates are analysed via a unit test as well as a test based on the evolutionary spectrum. Linearity and Gaussianity are analysed via bispectral test and compared with the more frequently employed domain tests, such as McLead-Li, and T-say tests. Finally, an evaluation of out of sample forecasting properties for eight methods Random Walk, ARMA, Bilinear, State dependent model, dynamic linear model, ARCH, GARCH and Garch -in-mean is made. Ten series of exchange rates are considered. Strong evidence for non-Gaussianity as well as non linearity is uncovered. The conclusion of nonlinearity is supported by McLead-Li and T-say tests, both which are based in the time domain. The ARCH/GARCH models embody this type of nonlinearity and

claim additional relevance by being leptokurtic (heavy-tailed) process. Ex-post forecasting exercise , where the random walk was pitted against ARMA, BL, SDM, ARCH, GARCH and GARCH-M models, the random walk fare poorly at short leads but at longer leads could be outclassed only by the ARCH/GARCH-M models. The performance of the linear ARMA models is uniformly poor and that of additive non-linear models (BL, SDM and DLM) more respectable but not a shinning success. In conclusion the study the dynamics of exchange rates is considerably more complex, but that a proper combination of time domain and frequency domain techniques can indicate appropriate modelling strategies to beat the random walk.

Ülengin and Ülengin (1994) attempt to compare five possible ways of forecasting the foreign exchange rate; namely Regression, ARIMA, VAR, Restricted VAR (RVAR), Bayesian VAR with the AHP (Analytic Hierarchy Process) models. In fact among them AHP is proposed as a new method of structuring an expert forecast of a foreign exchange rate. It allows the incorporation of current market knowledge and expertise to generate a subjective probability distribution of the future spot rate thus provide more accurate probabilities than the conventional forecasting approaches which can not accomplish this directly.

Macdonald and Marsh (1994) examined on a highly disaggregate database , whether individual forecasts produce efficient exchange rate predictions and also if the properties of forecasts change when they are combined. It is demonstrated inter alia , that some forecasters are better than others, but that most are not as good as naive no change prediction. It is found that pooling the forecasters information sets by combining their forecasts possibly adds to the accuracy of the predictors , but the gains mainly reflect the removal of systematic bias. The bias does not appear to be stable over time , and this may

explain the poor performance of combined forecasts. Non-parametric tests, which indicated differing abilities, could reflect one of two possibilities. There may just be very bad forecasters which make the merely poor look good by comparison. On the other hand, scarce but unincorporated information may not be randomly scattered, but rather lies in the hand of a select few.

Jorion (1995) examines the information content and predictive power of implied standard deviation (ISDS) derived from the Chicago Mercantile Exchange Options on foreign currency futures. The article finds that statistical time series models, even given the ex-post parameters estimates, are outperformed by ISDS. ISDS however, also appear to be biased volatility forecasts.

Chin and Meese (1995) examine the predictive performance of four structural exchange rate structural models using both parametric and non-parametric techniques. The findings confirm that fundamental exchange rate models forecasts no better than a random walk model for short-term predictions. For longer horizons, error correction terms can explain exchange rate movements significantly better than a no change forecast for a subset of models and currencies considered.

Sarantis and Steward (1995) compare the out-of-sample forecasting accuracy of a wide class of structural BVAR, and VAR models for major Sterling exchange rate over different forecast horizons. Proper attention to the long run properties and the short run dynamics of structural models can improve the performance of the random walk model. The structural model shows substantial improvement in medium-term forecasting accuracy, where as the BVAR model is more accurate in the short term. BVAR and VAR models in levels strongly outpredict these models formulated in difference from at all forecast horizons. Results show that the modified version of uncovered interest parity (MUIP)

model produces more accurate forecasts than the portfolio balance model at all forecast horizons and all exchange rates.

Mark (1995) investigates the extent to which the deviations of the exchange rate from a fundamental value suggested by economic theory are useful in predicting exchange rate changes over long horizons. Regression of multiple-period changes in the log exchange rate on the deviation of the log exchange rate from its “fundamental value, display evidence that long horizon changes in log nominal exchange rates contain an economically significant predictable component.

1.4.2. Group II : Studies of the Turkish Case

Akgiray, Aydoğan , Booth and Hatem (1989) investigate the causal relationship between the Turkish official and black markets for the US dollar and West German Mark, which are the currencies of Turkey’s two major trading partners. Hypothesis concerning the direction of causality are developed using Dornbusch et. al.(1983)and Olgun’s model of the black market exchange rate determination with the central bank of turkey’s policy for managing the country’s official rate. The hypothesis are tested using Granger type causality techniques. The conclusions are straight forward, with respect to weekly and monthly intervals, the relationship between the black dollar and mark exchange rates and their official counterparts are contemporaneous. The relationship is not suprising in most foreign markets exchange rate markets, the speed of adjustment to a new information is relatively fast. The daily exchange rate changes is markedly different. As hypothesised, the black mark leads the official mark. The relationship between the black and the official dollar is similar, but there is a evidence of weak feedback relationship. Its presence not only indicate the possibility of “second round” effects but also suggests that the Central

Bank of Turkey may respond to activities in the black market, even though this market is thought to be very small relative to the official market.

Öniş and Özmucur (1990) seek to explain the persistence of the phenomena; the inflationary dynamics of the post 1980 adjustment phase with reference to the interactions between exchange rate, price level and money supply. Results of a four VAR are presented and analysed. The strong impact of exchange rate devaluation on domestic inflation and the endogenous nature of the monetary base are the two results which deserve emphasis. The results overall imply that non-monetary supply side elements make a significant contribution to the inflation process. A definitive conclusion which emerges from the study involves the rejection of a pure monetary interpretation of the recent Turkish inflation.

Selçuk (1994) studies the currency substitution in Turkey. A vector autoregression model has been estimated employing the certain policy variables to investigate the dynamics of currency substitution in the economy. Dynamic impulse responses show that the residents have a preference for substituting for domestic currency because of real exchange rate depreciations. The results suggest that to stop or reverse the on going currency substitution process, a policy aiming to increase the real expected return on domestic assets should be adapted.

1.4.3. Group III : Other Studies

Lessard and Lightstone (1986) study the effects of the long and the short run behaviour to operating profit. They report that the company must understand its operating exposures and response to the risk of volatile exchange rates which raise profits and reduce risk.

Blair, Nachtman, Olson and Saaty (1987) indicate that the forecasts by the market experts can be more accurate than time series forecasts. The article describes a process for an expert forecast using Saaty's Analytic Hierarchy Process (AHP). It is concluded that current market knowledge and expertise generates a subjective probability distribution of the future spot rate, something not directly accomplished when using more conventional forecasting approach.

Bierman Jr. (1990) considers the relevance of inflation and exchange rate risk in common stocks where Mills (1991) investigates the relationship between interest and exchange rates and concludes to be first order integrated process but not cointegrated.

Hoek (1992) presents an empirical support for the asset-market approach of exchange rate. while Oskooee and Ltaifa (1992) investigate the effects of exchange rate uncertainty on the aggregate exports of 19 developed and 67 developing countries using cross sectional data, concluding that exchange rate uncertainty is detrimental to the exports of both developing and developed countries.

Cavaglia, Verschoor, and Wolff (1993) consider a previously unexploited survey data set of exchange rate expectations, and examines whether economic agents' exchange rate forecasts are unbiased. The findings are, exchange rate forecasts are not rational and that agents do not use available information in the market.

Choice (1993) studies the currency exchange rate forecast and interest rate differential. The findings strongly imply that currency exchange rate movements are not purely random. The conventional wisdom; a currency in a country with higher short term interest rate will appreciate in the future against those in countries with lower interest rate; is apparently valid in practical use.

Chinn and Frankel (1994) discuss whether exchange rate expectations are biased. The results imply that survey participants could reduce their forecast errors by betting against in forward rate. In fact investors would do better to forecast the exchange rate as random walk and ignore other current information.

Based on previous research, this study attempts to examine the probabilistic forecasting accuracy of semi-experts and novices. The effects of using dichotomous format on the performance of the participants are examined. This thesis is organised as follows. In Chapter 2, the procedure of the study is presented. In Chapter 3, the performance measures used in measuring the accuracy of probabilistic forecasting of currency/exchange rate prices are discussed. Chapter 4 presents results and Chapter 5 offers some concluding comments.

2. PROCEDURE

Participants of the study are classified into two groups. The first group (referred to as “semi-experts”) is composed of banking and finance professionals in the finance sector. 20 banking and finance professionals participated in the experiment. This group consists of people having experience and knowledge about foreign exchange rates and they act as semi-experts in the market. They are labelled as “semi-experts” since they are not directly responsible for foreign exchange dealings of their firms/banks.

The second group (referred to as “novices”) consists of 20 MBA students from the Faculty of Business Administration at Bilkent University. This group is comprised of students who are currently taking finance courses.

The task involves preparing probability forecasts regarding five currencies against Turkish lira and five exchange rates. The currencies and exchange rates with the highest volume of trade at the fx-market are selected to minimise the task complexity. This selection is made to ensure that currencies and exchange rates could easily be followed by all participants.

The choice of the task format employed and the variety of currencies and exchange rates used in this study are based on interviews with fx dealers and finance people in the sector. It is observed that the forecast horizons for fx dealers are short (daily and weekly)

where finance professional's forecast horizon are longer ; a month, three month even six month period.

The currencies and exchange rates used in the study are ; US dollar/ TL, Deutsche mark/ TL, English sterling/ TL, Swiss franc/ TL, Japanese yen/ TL and cross rates of dollar/mark, sterling/dollar, dollar/Swiss franc, dollar /yen, mark/yen . Cross rates and dollar/TL currencies are commonly traded by dealers whereas finance professionals generally concentrate on currencies against Turkish lira and dollar/Deutsche mark cross rate.

In response to the needs and the expectations of users dichotomous task structure is selected as an appropriate format that the forecasts could utilise to express their true judgement.

Accordingly, subjects are asked to make forecasts regarding daily price changes for above mentioned currency types and exchange rates using the dichotomous format. Forecasts are made regarding the price change between previous day's Reuters 11 a.m. TLFX-FY average rate price and the price that would be realised the current day.

Reuters 11 a.m. TLFX-FY average rate price is chosen for the study since it is generally accepted by banks and firms as an indicative price used in transactions. This rate is accepted to present the general tendency of the opening of market and at this time the market is said to be settled.

Forecasts with dichotomous format involves whether the forecasters believed the currency or the exchange rate in the following date would (a) increase or (b) decrease or stay the same in comparison to previous day Reuters 11 a. m TLFX-FY average rate.

Subjects are then requested to convey their degree of belief with the subjective probability for the forecasted direction of change . Specifically, subjects are asked to complete the following response form for each currency and exchange rate:

When compared to today's 11 a.m. rate, tomorrow's 11 a.m. rate will ,

- a. increase
- b. stay the same or decrease

Your forecast (A or B)

Probability that your forecast will indeed occur
(i.e. probability that the price change will actually
fall in the direction you predicted)

(Between 50% and 100%) :

In the beginning of the experiment participants are given detailed information about the research and examples are given to the related currencies and exchange rates . The design of the study is described and participants are told that certain scores of probability forecasting performance will be computed from their individual forecasts. Participants are told that their performance will be reported on a personal basis and no information about their direct or individual performances will be given to their managers and co-workers.

Each participant is presented with graphs that contain the past performance of currencies and exchange rates and the response sheets for a total of ten items (five currencies against Turkish lira and five exchange rates). The graphs contain information on the name of currency or exchange rate and its daily price changes since 1 August 1995.

Response sheets are comprised of the dichotomous format illustrated previously for each currency and exchange rate. Response sheets also contained instructions about the forecasting task.

Participants all received the experimental material with them before the beginning of the experiment date; 20th of November. The experiment started at 20th of November and participants were requested to make forecasts on 20th, 21st, 22nd, 23rd and 24th of November . On each day forecasts are made for next day's 11 a.m. rates depending on today's 11 a.m. rates. The experiment ended at 24th of November .

3. PERFORMANCE MEASURES USED

3.1. Mean Probability Score

The dichotomous format requires the forecaster to choose from two outcomes (i.e., whether the exchange rate price will (a) increase, or (b) decrease or stay the same). Forecasters are then asked to convey their degrees of belief in the occurrence of the chosen outcome by assessing subjective probabilities associated with the forecasted direction of change. Hence, f_i shows the forecaster's probability that his/her chosen outcome will occur for exchange rate i . Thus, $0.5 \leq f_i \leq 1.0$. Outcome index d_i assumes a value of 1 if the chosen outcome occurs for exchange rate i , otherwise takes a value of 0.

$$\overline{PS}_i = (f_i - d_i)^2$$

The mean of probability scores ($\overline{PS}$) over a specified number of forecasting occasions (i.e., over a given number of exchange rate) gives an index of a forecaster's probability judgement accuracy. The lower mean probability score indicates better performance in the overall accuracy with respect to the exchange rate in question.

3.2. Calibration

Calibration gives information about the forecaster's ability to match the probability assessments with the mean outcome indexes (i.e., proportions of correct forecasts). If a forecaster attains 50% correct forecast for all her .5 assessments, attains 60% correct for all .6 assessments, etc., then the forecaster is said to be perfectly calibrated. A calibration score computed as follows:

$$\text{Calibration} = (1/N) \sum N_p (\bar{f}_p - d_p)^2$$

where f_p is the probability forecast categories (e.g., each forecast can be rounded to the nearest tenth, resulting in 0, .1, .2, ..., 1.0) that could be used by the forecasters. N is the total number of forecasts (i.e., exchange rates) and N_p is representing the number of instances in which a forecast of f_p is used. D_p shows the mean outcome index (i.e., the proportion of times exchange rate price actually increases) corresponding to forecast f_p . The lower the calibration score, the better performance in assigning probabilities that match the proportion correct.

3.3. Scatter

Scatter gives a weighted average of the variability in the occasions where the predicted outcome actually occurs or the variability in the occasions when the predicted outcome does not occur. So, scatter is an index of the useless variability in the probabilistic forecast. Lower values are more desirable for this performance measure. A scatter index is computed as follows:

$$\text{Scatter} = [(N_1 * \text{Var}(f_1)) + (N_0 * \text{Var}(f_0))] / N$$

where $\text{Var}(f_1)$ is the variance of probabilities for all the N_1 cases when the exchange rate price increases, and $\text{Var}(f_0)$ is variance of probabilities for the N_0 cases when the exchange rate price do not increases. $N = N_1 + N_0$

3.4. Slope

Slope provides indication of the forecaster's performance in assigning higher probabilities to instances when her/his chosen outcome occurs than when it does not occur. The higher the value, the better the forecaster is able to discriminate. Slope is computed as follows:

$$\text{Slope} = (\bar{f}_1 - \bar{f}_0)$$

where $\bar{f}_1$ is mean of probability forecast for all the cases when the exchange rate price increases and $\bar{f}_0$ is the mean of probability forecast for all the cases when the exchange rate price does not increase.

3.5. Bias--Over/underconfidence

Bias shows the forecaster's performance in matching her mean probability assignments ($\bar{f}$) to the overall proportion of correct forecasts ($\bar{d}$),

$$\text{Bias} = \bar{f} - \bar{d}$$

If the mean of the probabilistic forecasts is greater than the overall proportion of correct forecasts, the forecaster is said to be “overconfident”. “Underconfidence” is shown when the overall proportion correct forecasts is higher than the mean probability assignments (Lichtenstein and Fischhoff, 1977).

4. FINDINGS

Performance measures used to evaluate various dimensions of forecasting accuracy of dichotomous forecasts are the mean probability score ($\overline{PS}$), scatter, slope, calibration, and bias scores as discussed in the previous chapter.

Outcome index is defined in terms of the correctness of the forecaster's predicted outcome. $\overline{PS}$ value over a specified number of forecasting occasions gives a measure of forecasters probability judgement accuracy. Scatter shows the extensive variability in forecasts where slope gives an indication of the forecaster's ability to distinguish when (s)he is incorrect. Calibration provides information of how closely the probabilistic forecasts match the proportions correct and referred to as "predicted outcome calibration". Bias (over/under confidence) shows the forecaster's tendency to judge the actual occurrence of the predicted outcome as being more likely (overconfidence) or less likely (underconfidence) than it really is. Positive bias scores reflect overconfidence (i.e., mean probability assigned exceeding overall proportion correct), and negative bias scores reflect underconfidence (i.e., overall proportion correct exceeding mean probability assigned).

The median, mean, standard deviation, minimum and maximum values of the above mentioned scores are presented for semi-experts and novices in Table 1 and Table 2.

Performance of semi-experts and novices are compared using Mann-Whitney U tests for each of the performance measures.

Table 3 displays the median values for the dichotomous forecasts of semi-expert and novices. It can be observed from this exhibit that dichotomous forecasts given by semi-experts attained better results than novices. Semi-experts attain better mean probability score ($\overline{PS}$) (p-value = .021) which means their probability judgement accuracy is better than novices.

F_{bar} values of semi-experts (.724) are higher than novices (.687) with p-value of .041. D_{bar} values of semi-experts (.732) are higher than novices (.640) with p-value of .003, concluding that semi-experts proportion of correctness of forecasts are better than novices. Semi-experts proportion of correctness of their forecasts are supported by their mean probability score, showing the accuracy of their results. Considering over/underconfidence scores for semi-experts D_{bar} values surpasses F_{bar} values, which revealed an underconfidence score, while for novices F_{bar} values exceeds D_{bar} values showing an overconfidence situation (p-value = .117). However both groups attain bias scores that are not statistically different than zero, displaying no significant over/underconfidence score.

Calibration scores indicating the performance in assigning the probabilities that match the proportion correct, are same for both semi-experts and novices having a p-value of .800 which is statistically insignificant. Semi-experts discrimination is better than novices (p-value = .037) as displayed a higher slope value. With a scatter score of .008, novices attain better scatter score than semi-experts (p-value = .037). Since scatter indicates the useless variability in the probabilistic forecasts, it can be concluded that novices do not scatter their forecasts. Semi-experts attain higher scatter scores, meaning their probabilistic forecasts are more widely scattered than novices.

5. CONCLUSION

This thesis aims to study various dimensions of probabilistic forecasting accuracy. Focusing on the financial domain, this work attempt to assess the probabilistic forecasting performances of semi-experts relative to novices under dichotomous task format.

Banking and finance professionals are comprised of people who are in the exchange rate business indirectly (not trading currencies and exchange rates directly) . Those people have finance background , and are well educated at their fields and have close relationship to the exchange rate markets . They are in the finance business and close to the financial news and information about the exchange rate business. MBA students in the study are comprised of people taking finance courses and are not close to the exchange rate business and far away from the financial news. The only information that is accessible for them is the graphs of the past performance and the REUTERS 11 a.m. TLFY-FY average rate values. They are away from the finance market and the financial news.

The study involves preparing probability forecast regarding five currencies against Turkish lira and five exchange rates. The currencies and exchange rates with the highest volume of trade at the market are chosen so that all items can easily be followed by all participants. The choice of the task format and the currencies and exchange rates which are used in the study are based on the interviews with fx dealers and finance professionals in the sector. Commonly traded currencies and exchange rates in Turkish fx-fx and tl-fx

market are; US dollar/TL, English sterling/TL, Swiss franc/TL and Japanese yen/TL and cross rates of dollar/mark, sterling/dollar, dollar/ Swiss franc, dollar/yen and mark/yen. Cross rates and dollar/TL currency type are commonly traded by dealers who are concentrating on the short forecasts horizons (daily or weekly). Finance professional are mostly concentrated on currencies against Turkish lira and their forecast horizon are longer; a month three month even six month period.

Forecasts with dichotomous format involve whether the forecasters believe the currency or exchange rate will (a) increase or (b) decrease or stay the same in comparison to previous day REUTERS 11a.m. TLFY-FY average rate. Participants are then requested to convey their degree of beliefs with the subjective probability for the forecasted direction of change. All participants have the experimental material with them before the beginning of the experiment date. The experiment start at 20th of November and end at 24th of November.

The performance measures used to evaluate various dimensions of forecasting accuracy of dichotomous forecasts are : mean probability score, calibration, scatter, slope and over/underconfidence. The dichotomous forecasting results for semi-experts and novices show that semi-experts attained better results than novices. Since they are working in the finance sector and close to the currency/exchange rate business, their mean probability scores attained better results showing that their probability judgement are better than novices.

Considering over/underconfidence scores they in fact does not display a great difference between two groups having $p\text{-value} = .117$. From the values, semi-experts are showing a very small negative bias score and novices are showing a very small positive bias score, indeed values very close to zero. This means both groups' performance in

matching their mean probability assignments to the overall proportion of correct forecasts are the same. This situation arises from the difficulty in forecasting currency/exchange rate price increases, especially for the exchange rates. Considering F_{bar} and D_{bar} values, semi-experts attained better scores than novices. Semi-experts D_{bar} values attain higher score of .732 than novices score .640, showing that the proportion of correctness of their forecasts are better than novices with a p-value of .003 which is statistically very highly significant.

Calibration scores also have the same values for both semi-experts and novices, meaning they both show the same performance in assigning probabilities that match the proportions correct. Also, p-value = .800 shows that this result is statistically not significant.

A lower scatter score which is more desirable, is obtained for novices. Scatter score which is the index of useless variability in probabilistic forecasts showed that, novices are distributing their probabilistic forecasts less than semi-experts did. The semi-experts group displays a higher slope value than novices meaning a better discrimination performance since they are close to the finance business.

In our investigation, we found that forecasting exchange rates is a difficult task. By using dichotomous format, semi-experts who are in the exchange rate business indirectly, attain better results than novices. This result indicates the importance of information and closeness to the financial market in forecasting of exchange rates. Another conclusion that can be derived from this study is that, familiarity to the subject (exchange rates), experience, availability of information and feedback has significant effect on the performance of the participants.

Further research about the use of probabilistic forecasting of exchange rates, may involve different task formats. Depending on the previous studies of Önköl and Muradođlu (1994), the study can be applied in multiple interval task format and the accuracy of the multiple interval task format can be tested for the same participating group of semi-experts and novices. Besides the multiple interval task format , the research investigating the effects of using interval task format and the point forecast task formats on the performance of probabilistic forecasts of exchange rates to the same group of participants are required. The study has to applied to dealers forecasts who are the experts in exchange rate business, in different task formats ; point forecasts , interval and multiple interval and dichotomous task formats. Comparisons of dealers/ semi-experts forecasts in point forecast, interval and multiple interval format and dichotomous format need to be conducted for future studies. The application of the same study is advised to be conducted for dealers/novices forecasts in different task formats . Finally, depending on studies of Önköl and Muradođlu (1994) , feedback studies on probabilistic forecasts of exchange rates need to be conducted. The effects of feedback on various dimensions of probability forecasting accuracy on experts, semi-experts and novices has to examined and feedback studies with dealers are required to examine whether forecast- horizon-dependent inverse expertise effect exists.

**TABLE 1 MEDIAN, MEAN , STANDARD DEVIATION MINIMUM AND
MAXIMUM VALUES FOR PERFORMANCE MEASURES OF
SEMI-EXPERTS**

	MEDIAN	MEAN	ST. DEVIATION	MINIMUM	MAXIMUM
$\overline{PS}$	.202	.201	.040	.120	.287
BIAS	-.003	.006	.101	-.188	.171
F_{BAR}	.724	.731	.071	.626	.911
D_{BAR}	.732	.725	.069	.620	.680
SLOPE	.049	.042	.047	-.047	.153
SCATTER	.011	.012	.006	.002	.023
CALIBRATION	.028	.038	.046	.007	.219

**TABLE 2 MEDIAN, MEAN , STANDARD DEVIATION MINIMUM AND
MAXIMUM VALUES FOR PERFORMANCE MEASURES OF
NOVICES**

	MEDIAN	MEAN	ST. DEVIATION	MINIMUM	MAXIMUM
$\overline{PS}$	.226	.228	.037	.174	.297
BIAS	-.056	.045	.081	-.080	.234
F_{BAR}	.687	.695	.062	.617	.851
D_{BAR}	.640	.649	.087	.500	.813
SLOPE	.017	.020	.036	-.058	.104
SCATTER	.008	.008	.003	.002	.013
CALIBRATION	.028	.035	.025	.008	.104

**TABLE 3 COMPARISONS OF PERFORMANCE MEASURES FOR
DICHOTOMOUS FORECASTS OF SEMI-EXPERTS AND NOVICES
(MEDIAN VALUES GIVEN; P-VALUES FROM MANN
WHITNEY U-TEST)**

	SEMI- EXPERTS	NOVICES	P-VALUES
$\overline{PS} \downarrow$	.202	.226	.021
BIAS	-.003	.056	.117
F_{BAR}	.724	.687	.041
D_{BAR}	.732	.640	.003
SLOPE $\uparrow$	.049	.017	.037
SCATTER $\downarrow$	.011	.008	.037
CALIBRATION $\downarrow$	.028	.028	.800

REFERENCES

- Akgiray V., Aydoğan K., Booth G.G, and Hatem J., “ A casual analysis of black and official exchange rates: the Turkish case “, *weltwirtschaftliches Archiv*, 25 (1989), 337-345.
- Bahmani-Oskooee M. Ltaifa N., “Effects of exchange rate risk on exports: crosscountry analysis”, *world Development*, 20 (1992), 1173-1181.
- Baille R. T. and Bollerslev T., “ The message in daily exchange -rates- a conditional variance tale”, *Journal of Business and Economic Statistics*, 7 (1989), 297-305.
- Bierman H. JR., “ Inflation, exchange rates, and investments in common stocks”, *The Journal of Portfolio Management*, 1 (1990) , 74-76
- Blair A.R., Nachtmann R., Olson J.E., Saaty T.L., “ Forecasting exchange rates: an expert judgement approach”, *Socio-Economic Planning Sciences*, 6 (1987), 363-369,
- Cavaglia S., Verschoor W.F.C., Wolf C.C.P., “Further evidence on exchange rate expectations”, *Journal of International Money and Finance*, 12 (1993), 78-98.
- Chinn M. and Frankel J., “ Patterns in exchange rate forecasts for twenty-five currencies ”, *Journal of Money, Credit, and Banking*, 4 (1994) , 759-770 .
- Chinn M.D. and Meese R.A., “ Banking on currency forecasts: how predictable is change in money”, *Journal of International Economics*, 38 (1995), 161-178.
- Choie K.S.N., “ Currency exchange rate forecast and interest differential “ , *The Journal of Portfolio Management* , 2 (1993), 58-64.
- Coninx R.G.F., “ Foreign Exchange Dealer’s Handbook” , 1986.
- Fama E.F., “ Forward and spot exchange- rates”, *Journal of Monetary Economics*, 14 (1984), 319-338.
- Friedmann D. and Vandersteel S., “ Short-run fluctuations in foreign exchange rates - evidence from data 1973-79”, *Journal of International Economics*, 13 (1983), 171-186
- Gerlow M.E and Irwin S.H., “ The performance of exchange rate forecasting models: an economic evaluation”, *Applied Economics*, 23 (1991), 133-142.
- Guerard J.B.JR., “ Composite model building for foreign exchange rates”, *Journal of Forecasting*, 8 (1989), 315-329.

Hoek T., "Explaining mark/dollar and yen/dollar exchange rates in the 1980s.", *Economic Letters*, 38 (1992), 467-472.

Hogan L.I., "A comparison of alternative exchange rate forecasting models", *The Economic Record*, (1986), 215-223.

Hsieh D.A., "The statistical properties of daily foreign exchange-rates- 1974-1983", *Journal of International Economics*, 24 (1988), 129-145.

Jorion P., "Predicting volatility in the foreign exchange market", *Journal of Finance*, 2 (1995), 507-528.

Kettell B. and Bell S., "Foreign exchange handbook", 1983.

Kim B.J.C., "Do the foreign exchange-rates really follow a random -walk- an empirical question revisited", *Economic Letters*, 23 (1987), 289-293.

Kim B.J.C. and Mo S., "Cointegration and the long -run forecast of exchange rates", *Economics Letters*, 48 (1995), 353-359.

Khodly S. and Sohrabian A., "Exchange -rates and prices- evidence from Granger causality test", *Journal of Post Keynesian Economics*, 13 (1990), 71-78.

Kling J.K. and Bessler D.A., "Calibration-based predictive distributions: an application of prequential analysis to interest rates, money, prices, and output", *Journal of Business*, 62 (1989), 477-499.

Khoury S.J., "Stability predictors and the forecasting of the foreign exchange-rates", *Journal of Business Research*, 14 (1986), 37-46.

Lai K.S. and Pauly P., "Random walk or bandwagon: some evidence from foreign exchanges in the 1980s", *Applied Economics*, 24 (1992), 693-700.

Lessard D.R., and Lightstone J.B., "Volatile exchange rates can put operations at risk", *Harvard Business Review*, 4 (1986), 107-114,

Macdonald R. and Marsh I.W., "Combining exchange rate forecasts: what is the optimal consensus measure?", *Journal of Forecasting*, 13 (1994), 313-332.

Mapletuft B., "Effective management of foreign exchange", 1991.

Mark N.C., "Exchange rates and fundamentals: evidence on long horizon predictability", *American Economic Review*, 1 (1995), 201-218.

- Mills T.C., “Modelling weekly data on UK interest and exchange rates”, *Applied Economics*, 23 (1991), 95-100.
- Nachane D.M. and Ray D., “Modelling exchange rate dynamics- new perspectives from the frequency domain”, *Journal of Forecasting*, 12 (1993), 379-394.
- Önkal D. and Muradoğlu G., “An exploratory analysis of portfolio managers’ probabilistic forecasts of stock prices”, *Journal of Forecasting*, 13 (1994), 565-578.
- Öniş Z. and Özmucur S., “Exchange rates, inflation and money supply in Turkey”, *Journal of Development Economics*, 32 (1990), 133-154.
- Sarantis N. and Stewart C., “Structural var and bvar models of exchange rate determination: a comparison of the forecasting performance”, *Journal of Forecasting*, 14 (1995), 201-215.
- Selcuk F., “Currency substitution in Turkey”, *Applied Economics*, 26 (1994), 509-518.
- Ülengin F. and Ülengin B., “Forecasting Foreign exchange rates: a comparative evaluation of AHP”, *Omega International Journal Management Science*, 22 (1994), 505-519.
- Wadhwani S.B., “Are exchange rates excessively volatile”, *Journal of International Economics*, 22 (1987), 339-348.
- Wolff C. C.P., “Exchange-rates, innovations and forecasting”, *Journal of International Money and Finance*, 7 (1988), 49-61.