Marmara Üniversitesi
İ.İ.B.F. Dergisi
YIL 2008, CİLT XXIV, SAYI 1

THE EFFECTIVENESS OF THE RISK MANAGEMENT TECHNIQUES IN THE TURKISH BANKING SYSTEM

Yrd. Doç. Dr. R. Ceyda ÖZTÜRK[*]
Araş. Gör. Meltem GÜRÜNLÜ[**]

ABSTRACT

The outstanding purpose of this study is to propose alternative solutions towards improving the instable structure of Turkish Banking Sector which has not had fully the reflexes of an open market economy yet and which is frequently exposed to sudden and excessive fluctuations in the prices of financial instruments.

In today's increasingly global world in which the financial volatility has increased and international competition has become a core subject, Turkish banks should comply with the international regulations which have become benchmark standards in the banking industry by arousing world wide acceptance and they should also measure their risk exposures more sensitively by making use of quantitative risk measurement methods which are an indispensable part of modern risk management process. This subject is emphasized both from the regulatory perspective which requires the banks to allocate their capital charges in parallel with their risk exposures; to achieve a capital adequacy ratio so that they may guarantee the soundness of their banking operations and also from the point of view of forming an integrated risk management philosophy which comprehends all their risk exposures in compliance with their business goals.

Within this context, the basic research methodology used in the thesis becomes a descriptive analysis which systematically analyses the underlying assumptions and variables of the various approaches which are grouped under two main headings as traditional and modern. An empirical study on Value At Risk (VaR) method, which is evaluated as the most effective method in measuring the primary source of risk for the Turkish banks - the foreign exchange risk-, is performed and the validity of the model in estimating the realized risks is back-tested.

[*] Marmara Üniversitesi, İngilizce İşletme Bölümü Öğretim Üyesi, ceydaozturk@maltepe.edu.tr
[**] Maltepe Üniversitesi İşletme Bölümü, meltemg@maltepe.edu.tr

The finding proves the accuracy of the chosen model for the portfolios, the only exposure of which is the foreign exchange risk and the asset returns of which inhere the normal distribution property. When the maximum loss that may be faced for each day of the one year period estimated by the model is compared with the realized losses for the corresponding period, it is concluded that the model is consistent and is applicable in the Turkish Banking Sector for measuring the market risk.

Key Words: *Banking System, Risk Management, International Regulations*

TÜRK BANKACILIK SİSTEMİNDE KULLANILAN RİSK YÖNETİM TEKNİKLERİNİN ETKİNLİĞİ

ÖZET

Bu çalışmanın temel amacı, açık piyasa ekonomisi reflekslerine henüz tam olarak sahip olmayan Türk Bankacılık Sektörünün, finansal enstrümanların fiyatlarındaki ani ve aşırı dalgalanmaların sıklıkla yaşandığı istikrarsız yapısını iyileştirmeye yönelik çözüm önerileri sunmaktır.

Giderek daha fazla küreselleşen, finansal hareketliliğin arttığı ve uluslararası rekabetin önem kazandığı günümüz dünyasında, Türk bankaları, risklerini en etkin ve etkili şekilde yönetmek durumundadırlar. Bunun için de, dünya çapında genel kabul görerek bankacılık endüstrisinde standart haline gelmiş risk yönetimi ile ilgili uluslar arası düzenlemelere uyum sağlamak ve modern risk yönetiminin bir parçası olan niceleyici risk ölçüm modellerinden yararlanarak maruz kaldıkları riskleri daha hassas bir biçimde ölçmek zorundadırlar. Bu konu, hem bankaların maruz kaldıkları risklere paralel sermaye ayırmasını; belli bir sermaye yeterlilik oranını sağlamasını ve böylelikle bankaların faaliyetlerini sağlıklı bir şekilde yürütmesini öngören düzenleyici perspektiften, hem de bankaların kendi işletme amaçlarına uygun, karşı karşıya kaldıkları tüm riskleri kapsayabilecek bütünleşik bir risk yönetim anlayışının oluşturulması açısından vurgulanmıştır.

Bu çerçevede, çalışmada kullanılan temel araştırma yöntemi, risk yönetiminde, başlıca modern ve geleneksel ana başlıkları altında toplanan çeşitli yaklaşımların belirli varsayımlarının ve değişkenlerinin sistemli bir analize tabi tutulması yoluyla karşılaştırmalı olarak incelenmesi olmuştur. Bunlar arasından seçilen ve Türk Bankalarının ana risk kaynaklarından birisi olan döviz kuru riskini ölçmede en etkili olabileceği düşünülen Riske Maruz Değer (RMD) modeli ile ilgili ampirik bir çalışma yapılmış ve modelin gerçekleşen riskleri tahmin etmekte başarılı olup olmadığı geriye dönük olarak test edilmiştir.

Elde edilen bulgular, kullanılan modelin, sadece döviz kuru riskine maruz ve varlık getirileri normal dağılım özelliğine sahip olan portföylerde doğruluğunu göstermiştir. Modelin tahmin ettiği bir yıl boyunca, her gün karşılaşabilecek maksimum kayıp miktarı, aynı dönem boyunca gerçekleşen kayıp miktarı ile karşılaştırıldığında,

modelin tutarlı olduğu ve Türk Bankacılık Sektöründe piyasa riskini ölçmede kullanılabilir olduğu sonucuna varılmıştır.

Anahtar Kelimeler: *Bankacılık Sistemi, Risk Yönetimi, Uluslararası Düzenlemeler*

1. Introduction

In today's world where the blocks on free circulation of capital are disappearing and financial volatility is increasing, the types of risks that the banks face and manage are increasing and becoming more sophisticated. So, in addition to capital adequacy regulations which were initiated by the Basle Committee on Banking Supervision of BIS – the most important international financial regulatory institution in the international banking system -, the capability of managing risks has been a fundamental priority for preserving the safety and soundness of the banking system which is free of competitive distortions.

Also, the new risk profile of modern banking necessitates a more proactive approach of banks to risks, risk-based strategic planning and an effective and integrated risk management system in which the risks are better defined, quantitatively assessed, actively controlled and accurately measured. This is because the income from trading operations and investments in the modern banking implies higher volatility of earnings and profitability than the income from traditional borrowing and lending functions of the banks.

The attempts for financial liberalization during 1980's have exposed Turkish banks to new sources of risks which were unknown to them; interest rate and foreign currency risks.The banks actively engaged in trading of governmental debt securities which were lucrative due to their high yielding risk premiums while holding excessive open positions in foreign currency most of which were in the form of short term liabilities. But, the absence of full-fledged risk measurement and management systems have caused them to face with insurmountable capital erosion in case of unpredictability in the market prices where a devaluation risk is always highly likely to occur.

In spite of functioning as a fund transferring mechanism to finance the real sector, the banks transferred these funds to finance heavy government borrowing. This, severely, crowded-out the private sector investments, increased the injection of hot money – short term foreign cash in flows- and there by increased the fragility of the overall economic system. The three headings are important when determining the significant factors which contributed to the instable banking environment and which must be cured: unfair competition, capital deficiency and liquidity risk from short-term foreign debt.

- *Unfair competition* from state banks and reluctance of authorities to let non-viable banks fail hampered the development of a commercially-oriented banking system. Unfair competition from unsound banks has destroyed bank profitability. Government and Central Bank involvement in the rescuing of troubled banks lead to financial and fiscal problems, since with such operations; banks may undertake riskier lending and offer higher returns to attract funds than otherwise.

- *The capital deficiency* of many banks implied little risk of further loss and significant upside gains to bank's stockholders. With little or no capital at stake, many banks have made risky investments.

- *Liquidity risk from short-term foreign debt* further increased fragility and made banks vulnerable to any shocks to their capital flow.

Much progress have been made in our country in an effort to strengthen the capital base of banks and to make them comparable with international banks since the 1988 Accord of the Basle Committee for calculating the capital adequacy ratio in relation with credit risk (The Cooke Ratio) was accepted in October 26, 1989 with the Communiqué No 6 of the Banking Law No 3182.[1] And, this ratio became completely effective as of the end 1992 after a gradual transition period of five years. However, there has long been an important deficiency with regard to calculation of market risk exposure of banks in relation to their capital adequacy. The efforts have become more intensive after the establishment of an independent supervisory agency (BRSA) in 1999 by the enactment of new banking law (numbered 4389) in line with the promises given to IMF about stabilization of the banking sector in order for them to survive in a non-inflationary economic environment and massive steps have been taken . One of them is the regulation issued on February 2001 on the "Measurement and Assessment of Capital Adequacy of Banks"[2]. Accordingly capital charges for market risks will be included in the capital adequacy ratio by the beginning of 2002. This regulation is adopted from the Basle Committee's "Amendment to the Capital Accord to Incorporate Market Risks" which is dated 1996.[3]

This important regulation presents alternative approaches to measure the market risk exposure and the criterions to be fulfilled by the banks in order to be approved by the national supervisory agency. The main focus of this study, hence, is directed to make analysis and comparisons about these different methodologies which, in a near future, our banks will be prevailingly and effectively using. Because of the fact that banks are too different with their risk profiles, risk controls, strategies and approaches to managing risks to be supervised and regulated by one yard stick, a one size fits all supervisory and regulatory framework such as the Standard Method (which is one of the alternatives mentioned) provides may be inconsistent with the existing and the evolving banking structure.

On the other hand, the Value At Risk (VaR) methodology , the usage of which is encouraged by BIS as an internal risk measurement approach in the calculation of minimum market risk capital charge to obtain the capital adequacy ratio, is the most prevailingly used one among risk management method and it has an important place in today's risk management philosophy. VaR gives the chance of bringing the risks appearing from different positions and various risk factors together and explains them with a single value. VaR can also be used for risk reporting, setting risk limits, performance measurement, internal capital allocation as well as for regulatory capital purposes.

---

[1] Kürşat Aydoğan, & Hasan Ersel (Ed.), **Issues On Banking And Competition In A Changing World,** Ankara: Central Bank of Republic of Turkey (CBRT), May-1992, p.21-22

[2] Banking Regulation and Supervision Board, **Regulation on Measurement and Assessment of Capital Adequacy of Banks**, *Official Gazette No:24657*, January 31, 2002

[3] Basle Committee on Banking Supervision, **Amendment to the Capital Accord to Incorporate Market Risks,** BIS, January 1996

The use of this model became obligatory in many countries and financial institutions to comply with the capital accord's requirements and it has become a benchmark industry standard. VaR is a concept that is based on the estimation of maximum loss in the value of a portfolio or an asset, for a time period with a certain probability. There are also, different approaches to calculate VaR, appropriateness or the choice of which depends on the properties of the instruments in the portfolio and the market. These are, Parametric Approach (or Variance –Covariance Approach), Historical Simulation and Monte- Carlo Simulation Approaches.

In this study, an analysis of relevant aspects of the assumptions and the variables used in different risk management techniques by decomposing their characteristics is performed. At first, a comparison is made between traditional approach and modern approach in order to make a precise statement of what has changed in the banking system and which approach should be preferred to cover the new strategic challenges of the banking. And, then a comparative investigation of different methodologies under modern approach is made in order to put forth their discernable qualities for their applicability. Finally, considering that the major risk source in the Turkish banking system is the foreign currency risk exposure, the applicability of Variance-Covariance approach to VaR is tested through validation by back-testing procedure which compares actually realized losses with those which were estimated by VaR method.

2. Comparison of Different Risk Management Methods

In today's environment of more proactive risk management, there is a tendency to standardize the risk management methodologies within an effort to come up with more stable, structured and comprehensive risk management and measurement tools. The most prevailing methods in traditional risk management are gap analysis, duration analysis, sensitivity analysis, scenario analysis[4] . The basic idea behind these methods to quantify risk exposures is the calculation of how the net interest income of the bank will be affected in response to a change in interest rates.

The traditional approach provides useful tool for telling the bank's degree of exposure to interest rate risk, but it is unable to cover all market risk or it is adaptable to all asset classes like equity, foreign exchange, and commodities. Turkish banks as many leading global banks have to implement additional risk management techniques because existing models failed to prevent losses which occurred as a result of financial turbulence during the past years.

Traditional asset and liability management, as a result of accounting conventions, ignores the change in the value of the instrument since positions are not marked to market. This leads to the creation of positions which look attractive on paper because of high interest earnings, but which would not perform as well if their change in market value is considered.

A more dynamic approach focusing on day to day marking to market risk management, using volatility, portfolio management and diversification concepts is

[4] Kevin Dowd, **Beyond Value At Risk: The New Science of Risk Management**, England: John Wiley & Sons, Ltd., 1998, p.9-12

strongly needed in our country, because of the fact that Turkish market is highly volatile. So, for the last couple of years the concept of risk management and more specifically Value-At-Risk has become more and more interesting in Turkish market. Hence, the development of risk management concepts and risk procedures and expanding the use and development of risk management thinking based on modern approach within banks' operations have become critical factors in determining the competitive strength of the banks.

The outstanding method in the modern approach- Value At Risk- is a single summary statistical measure of possible portfolio losses, referring to a particular amount of money, the maximum loss we are likely to lose over some period, at some specific confidence level.[5] It provides a common consistent measure of risk across different positions and risk factors. It takes into account of the correlations between different risk factors. If two risks offset each other, the VaR allows for this offset and the overall risk will be low. So, it handles portfolio risks in a more meaningful way.

The elegance of the VaR solution is that it works on multiple levels, from the position specific micro level to the portfolio based macro level. VaR has become a common language in the banking industry about aggregate risk taking, both within an organization and outside (analysts, regulators, rating agencies, and shareholders). With VaR, Turkish banks will be able to develop a general measure of economic loss that could equate risk across products and aggregate risk on a portfolio basis where the traditional measures of risk exposure were inadequate. (Table 1)

[5] Phillippe Jorion, **Value At Risk: The New Benchmark for Controlling Market Risk,** USA: McGraw-Hill Company, 1997, p.18

Table1. Traditional Approach versus Modern Approach

	TRADITIONAL APPROACH	MODERN APPROACH
Risk Concept & Types of Risks	Managing structural risks Limited to liquidity and interest rate risks	Managing trading risks Provides an overall risk management framework
Goal	Maximization of shareholders' wealth by optimizing the risk-return trade-off	Maximization of shareholders' wealth by optimizing the risk-return trade-off
Objective	Reducing volatility of annual earnings Time frame is annual	Efficient use of capital in activities in much shorter time-horizons Time frame is daily
Framework	Static management. This is consistent with the maintenance of the portfolios to maturity.	Dynamic management. This presents continuous opportunities for value optimization
Regulatory Tools	Traditional approach is a product of a regulated environment where the balance sheet constraints, interest rate controls or specific regulations, regarding participation in specific activities exist.	Modern Approach is a product of deregulated environment which includes capital-based controls, requiring minimum capitalization levels in proportion with the risks taken by the bank. The Basle Committee's Capital Accords are strongly in favor of modern risk management techniques.
Projection	Projects income statement over extended time periods; i.e. until most of the transactions on the books mature Return is only defined as net interest earnings; gains and losses occur at the same time they show up in the accrual accounts or when they are realized following the accounting principles Interest rate-based risk measures like gaps and durations are used. The emphasis is on accounting measures of value	Projects market value changes over short-time-periods The change in the price component of the return function is important. It provides a mark to market approach and makes use of volatility, portfolio management and diversification concepts. Current prices and rates are used to estimate and measure the risk of a portfolio. The emphasis is on current market prices. The value of the portfolio is established on a liquidation basis.
The Degree of Comprehensiveness	Covers only on-balance-sheet oriented risks and is not easy to translate across all asset classes.	More comprehensive. It covers all risks, either on-balance-sheet or off-balance-sheet. It is adaptable to all asset classes (debt, equity, currency and commodities)

There are three major methodologies for calculating VaR, each with unique characteristics (Table 2). The VaR method chosen should be based on the composition of portfolios, types of risk factors to be measured and the expected market conditions.

Table2. Different Methods in the Modern Approach

MODERN APPROACH TO RISK MANAGEMENT			
	Variance-Covariance Approach	**Historical Simulation Approach**	**Monte-Carlo Simulation Approach**
Description	Estimates VaR with equation that specifies parameters such as volatility, correlation	Estimates VaR by reliving history; takes actual historical rates and revalues positions for each change in the market.(Takes actual past market movements as scenarios)	Estimates VaR by simulating random scenarios and revaluing positions in the portfolio. (Generates random hypothetical scenarios)
Applications	Accurate for financial instruments which are linear (the price change in the instrument is in proportion to a movement in the underlying asset), Easy to implement for portfolios restricted to currencies. But, for bonds there is need to map the instruments onto their standard positions. The computation relies on mathematics.	Appropriate for all types of instruments linear or non-linear. Easiest to implement; does not need a high level of mathematics, but requires a significant amount of daily rate history. No need for correlations and volatilities	Appropriate for all types of instruments linear or non-linear. The most difficult; computationally intensive and time consuming. This involves revaluing the portfolio under each scenario.
Valuation	Delta-valuation[6]	Full-valuation[7]	Full -valuation
Assumption for the Distribution of Returns	Assumes normally distributed returns	Assumes that exact distribution of past returns forecasts future return distribution.	Allows a variety of distributional assumptions. Volatility and correlation

[6] Delta Valuation assumes that potential loss arises from the product between sensitivity to portfolio price changes and potential changes in these prices.
Potential Loss= Sensitivities to price changes * Potential changes in the price

[7] In a Full- Valuation method, the potential portfolio loss is calculated from the portfolio valuation at different price levels.
Potential Loss= Value at potentially changed prices - Value at original prices

		Performs no statistical fittings.	forecasts are still based on statistical fitting of historical returns.
Advantages	For large portfolios where option-like instruments do not exist, provides a fast and an efficient method. The most recent observations are given more weight.	Applies to any type of instruments, either linear or non-linear	Permits the use of various distributional assumptions and therefore has potential to address the issue of fat tail. Applies to any type of instruments, either linear or non-linear.
Disadvantages	Dependence on normality assumption. Describes bad losses on a normally bad day. It is unable to address fat tail problem or lepto kurtosis where there are more occurrences far a way from the mean than predicted by the standard normal distribution	It gives the same weight to all observations in the period. Lacks flexibility. It does not allow one to try different values for volatilities and correlations to test the sensitivity of VaR to these assumptions. If the portfolio is large and complicated, it may be impossible or impractical to obtain historical data on all instruments involved.	Large amount of computational power. Dependence of results on specified models and stochastic processes

3. Methodology and Data Analysis

Considering that the primary risk source for the Turkish banks is their foreign currency risk exposure that they have due to bearing huge amount of open positions in the foreign exchange, an empirical study of VaR is performed on a portfolio which is exposed to real changes in the prices of the foreign currency risk factors. Then, by means of the back-testing method, the validity of the model is tested.

For the purpose of this study, We work with a foreign exchange risk exposed portfolio which is made up of randomly generated positions (each position being equal to 1 million USD) in 10 currencies: USD, EUR, AUD, DKK, GBP, CHF, SEK, JPY, CAD, NOK.

We obtained currency quotation (the prices of the risk factors) from daily bid quotations published by Central Bank of Republic of Turkey (CBRT), for the period October 26,1999 - December 31, 2002. The one-day VaR forecasts are constructed for a 255 day period, for the year 2002. The reason for choosing the year 2002 is the banks' beginning to calculate their regulatory capital adequacy ratios which include their VaR

based market risk exposures in accordance with the BRSA's regulation relating to "Measurement and Assessment of the Capital Adequacy of Banks" .

The application of the Variance- Covariance Approach (also, named as Parametric VaR) on the above mentioned foreign exchange risk factors includes a one year period. The validation of the VaR model is made by *back-testing*, which verifies that the actual losses are in line with the risk measured by the VaR method for the one year period. From January 2, 2002 to December 31, 2002, the number of the applications is 255. For every day of the application, the previous 550 working days data are used to calculate the Value At Risk. [8]

By means of the chosen method which is also known as the Analytical Method, the portfolio VaR may be directly computed from volatilities and correlations of the risk factors. In other words, Parametric VaR is based on the estimation of the variance – covariance matrix of asset returns, using historical time series of asset returns to calculate their standard deviations and correlations. The underlying assumption of this method is that the portfolio's profit and loss profile is linear and that the position returns (in percentage changes) are normally distributed. That is there is low probability that an observation is far a way from the mean and high probability that an observation will be close to the mean. This, also, means that the variance –covariance matrix completely describes the distribution.

If the portfolio is composed of linear instruments like bonds, spot and forward foreign exchange positions, equity and commodity positions, Variance- Covariance Approach provides the most suitable method for computing VaR. If the portfolio is made up of non-linear instruments which have non-symmetric return distributions like options, interest-rate derivatives or mortgages, this method will be inadequate to measure the risk.

In this study, the portfolio is, simply, composed of foreign exchange positions in 10 different currencies. The results of the normality tests[9] showed that the asset returns are normally distributed. So, Parametric VaR or Variance- Covariance Approach is chosen as the most suitable method for accurately measuring market risk.

4. The Formulation of the Variance- Covariance Method

The generalized formulation of the VaR computation is:

$$VaR = P_0 \cdot \alpha \cdot \partial \cdot \sqrt{\Delta t}$$

This may be expressed simply as;

VaR = Marked to Market Value of the Position x Confidence Interval Constant x Standard Deviation of the Variable x Holding Period Constant

*The **marked-to market value of the position*** is found by multiplying the daily foreign exchange rates by the amount of the market risk exposed position in order to find the daily realized gain or loss,

[8] Risk Metrics, **Technical Document**, New York: JP Morgan- Reuters, 4th Edition, 1996, p.100
[9] To test the normality assumption, Kolmogorov- Smirnov test is used.

Confidence interval is another parameter used in the calculation of VaR. Basle Committee requires that the banks should use 99% confidence interval. But, in JP Morgan's Risk metrics 95% confidence interval is used. A higher confidence interval will lead to a higher VaR outcome. Accordingly, the confidence interval constants are 1.65 for 95% confidence interval; 2.33 for 99% confidence interval. (The Variance- Covariance method assumes that the distributions of the underlying risk factors and the portfolio are normal. Under this assumption, the loss exceeds 1.65 times the standard deviation of portfolio value with a probability of 5% and exceeds 2.33 times the standard deviation of portfolio value with a probability of 1%).

VaR indicates the maximum loss that can occur with probability of less than 1% (BIS) or 5% (JP Morgan's Risk metrics). If it is assumed that there is 252 working days in a year, then the VaR value is expected to be exceeded 3 days (252*0.01) a year or 13 days (252*0.05) a year.

Standard Deviation is the measure of volatility of price of an instrument. The method used in the computation of standard deviation is based on Exponentially Weighted Moving Average (EWMA) methodology, which differs from Equally Weighted Moving Average methodology because of the different weights associated with the used past observations. Exponentially Weighted Moving Average methodology emphasises recent observations by using exponentially weighted moving averages of squared deviations.

Holding period is the length of time from today t o the horizon date at which we attempt to model the loss of our portfolio of transactions. The holding period and market risk are directly related. VaR depends on the measurement of price changes within the given holding period.

The most common choice of holding period for internal VaR calculations is 1 day; because, this gives the ability to liquidate the portfolio (especially, when the portfolio is composed of highly liquid instruments as foreign exchange position, and bonds. For example, JP Morgan uses 1 day in it's Risk metrics approach. But, BIS specifies a holding period of 10 days, because in case of negative market conditions, it is considered that it would be hard to liquidate the positions. There is an assumption in the VaR calculation that the portfolio is not going to change over the holding period (the assumption of static portfolio over the holding period). In this analysis, 1 day holding period is used for the aim of back-testing.

The ***time series of data or the observation period*** on the risk factor for calculating related volatility estimations and correlations is another parameter of the VaR computation. This is in parallel with the strategic targets of the banks. A short observation period may be suitable for more sensitiveness to changes in the prices. A minimum historical data set of one year which should be updated regularly is proposed by the Basle Committee. The BIS requires a minimum weighted average maturity of the historical data used to estimate volatility of 6 months, which corresponds to a historical observation period of at least 1 year for equally weighted data. The volatility must be updated at least quarterly; and more often if market conditions warrant it. In this analysis, the observation period (Sampling period) is between January 1 and December 31, 2002.

The ***correlation*** between the assets in a portfolio must also be measured. The calculation of correlation based on historical data may lead to inaccurate results by not reflecting the exact impact, especially, in case of a crisis. To avoid this risk, the Basle Committee proposes a single VaR number calculation by aggregating the individual VaR numbers for different groups of risk factors (interest rate, foreign exchange rate, equity, commodity risk groupings) and the correlation assumptions to be used between different assets in each risk factor group should be supervised by the national supervisory authority. This approach disregards the cross correlations among risk groups. Therefore, the VaR computation is expected to be higher. Banks should reassess their data sets whenever market prices are subject to material changes and they must perform stress tests on the stability of the correlations. In this study, by the help of the variance-covariance matrix computed using the historical data, the correlations among risk factors (foreign exchange rates) are computed and included in the calculation of VaR.

5. Back-testing

To measure the accuracy and validity of the VaR model, the *back-testing* method is used. In back testing, the basic concept is to compare the actual observed change in the value of the portfolio with the risk estimate provided by the VaR calculated. The essential element is to measure the accuracy of the model prediction against actual changes in portfolio value and to ensure that the model estimates the risk consistent with the desired confidence level.

The key steps in back-testing are as follows:

1) VaR estimates using the relevant VaR model are generated for the year 2002 and stored.

2) Actual portfolio profits and losses are calculated using normal mark to market procedures.

3) Periodically, the actual daily mark-to-market gain or loss is compared to the daily VaR measures.

"… The back-testing framework to be applied entails a formal testing and accounting of exceptions on a quarterly basis using the most recent twelve months of data… The national supervisor will use the number of exceptions (out of 250) generated by the bank's model as the basis for a supervisory response…."[10]

4) The error fraction (or exceptions) is then calculated as the number of occasions on which the actual trading result exceeded the VaR risk measure.

To the extent that the error fraction is within or outside the acceptable ranges determines the validity of the risk model.

The back tests to be applied compare whether the observed percentage of outcomes covered by the risk measure is consistent with 99% level of confidence. That is,

[10] Basle Committee on Banking Supervision, **Supervisory Framework for the Use of Back testing in Conjunction with the Internal Models Approach to Market Risk Capital Requirements**, BIS, January 1996

they attempt to determine if a bank's 99th percentile risk measures truly cover 99% of the firm's trading outcomes. 99% is the desired level of coverage or the true level of coverage.

The back testing framework involves the use of risk measures calibrated to one-day holding period. But, for regulatory purposes to be used in the calculation of capital adequacy ratio, the maximum loss over a 10-day period at the 99% confidence level must be calculated.[11] This measurement assumes a static portfolio over the holding period. This means that one exception would be excepted in 1000 business days (4 years). If the exceptions are so infrequent, a very long run of data has to be observed to obtain statistically significant conclusion about the risk measurement model. Because of this, regulators require a holding period one day to be used for back testing.

Basle Committee on Banking Supervision sets out its requirements for back testing in conjunction with the internal models approach to market risk capital requirements. The key points of the requirements can be summarized as follows:

- Risk figures for back testing are based on a 1-day holding period and a 99% confidence interval.
- A 1-year observation period is used for counting the number of exceptions
- The number of exceptions is formally tested quarterly.

In this study, 1- day VaR forecasts are constructed for a 255 day period at 99%, 97.5%, 95% and 90% confidence levels and for each day the forecast is measured against the portfolio's daily realized profit and loss (P&L) . And, it is found that the overall model performs reasonably well. It is seen that the observed real portfolio loss exceeds the VaR estimate twice at 90% and 95% confidence levels and once at 97% and 99% confidence levels. These exceptions are shown in the graphs which are presented below.

Accordingly, at 99% confidence interval, there is only one exception and this stays within the BIS's green zone which requires no increase in the multiplication factor. So, in order to find the minimum VaR based capital charge for market risk, it is found enough to multiply the VaR figure at 99% confidence interval level over 10 days holding period by 3 (the multiplication factor as stated in the *Amendment to the Capital Accord to Incorporate Market Risks*.) and there is no need for increase in multiplication factor. In other word there is no need for a plus factor. Because, there is no way to tell if the number of exception is abnormally small or whether the model systematically overestimates risk.

6. Conclusion

The results show that the Parametric Model works well to measure foreign exchange market risk and provides enough accuracy with a limited number of exceptions that occurred. The estimated maximum loss found by using this model is consistent with the actual observed loss of the portfolio which is found by marking to market prices, with 99% confidence level. The usage of the Exponentially Weighted Moving Average (EWMA) in computation of the standard deviation is especially critical in emerging

[11] Basle Committee on Banking Supervision, **Amendment to the Capital Accord to Incorporate Market Risks,** BIS, January 1996, p.44

countries like Turkey where the volatility of market prices is high, because this method takes into account the most recent observations by determining a decay factor to determine the rate at which the weights on past observations decay as they become more distant in time.

The findings prove the accuracy of the chosen model for the portfolios, the only exposure of which is the foreign exchange risk and the asset returns of which inhere the normal distribution property. When the maximum loss that may be faced for each day of the one year period, estimated by the model is compared with the realized losses for the corresponding period, it is concluded that the model is consistent and is applicable in the Turkish Banking Sector for measuring the market risk.

REFERENCES:

AYDOĞAN, Kürşat , & ERSEL, Hasan (Ed.), **Issues On Banking And Competition In A Changing World,** Ankara: Central Bank of Republic of Turkey (CBRT), May-1992, p.21-22

BANKING REGULATION AND SUPERVISION BOARD, **Regulation on Measurement and Assessment of Capital Adequacy of Banks**, *Official Gazette No:24657,* January 31, 2002

BASLE COMMITTEE ON BANKING SUPERVISION, **Supervisory Framework for the Use of Back-testing in Conjunction with the Internal Models Approach to Market Risk Capital Requirements**, BIS, January 1996

BASLE COMMITTEE ON BANKING SUPERVISION, **Amendment to the Capital Accord to Incorporate Market Risks,** BIS, January 1996, www.bis.org

DOWD, Kevin, **Beyond Value At Risk: The New Science of Risk Management**, England: John Wiley & Sons, Ltd., 1998, p.9-12

JORION, Phillippe, **Value At Risk: The New Benchmark for Controlling Market Risk,** USA: McGraw-Hill Company, 1997, p.18

RISKMETRICS, **Technical Document**, New York: JP Morgan- Reuters, 4th Edition, 1996, p.100, www.jpmorgan.com/Risk Management/RiskMetrics.html