CESAG

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PROJECT

TOPIC:

MEASURING EXCHANGE RATE RISK WITH THE VALUE AT RISK APPROACH : ILLUSTRATION AND APPLICATION

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In sign of our gratitude to the Lord, to our parents for their total support,
and to all the people who have contributed to the final achievement of this project.

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May the Lord bless each of you and fulfil your desires.

FOREWORD

The need for a high level post graduate training program in banking and finance has been expressed time and time again by the heads of African central banks, financial institutions and senior corporate executives.

This need has led to the setting up of a masters program in banking and finance designed to provide advanced technical and managerial training for mid-to senior level staff of both public and private sector financial institutions and business enterprises . The programme is located at the"Centre Africain d'Etudes Superieures en Gestion" (CESAG), the Centre for Advanced Studies in Management in Dakar Senegal.

The program is an advanced one, and organised in such a way as not to duplicate similar programs being offered by other African universities.
Its international scope allows students to be at the same level and quality of education as their counterparts in Europe and the United States and be bilingual (English and French) as well.

This full time programme lasts for 11 months; 8 months of intensive theorical courses with well known lecturers in their fields and a 3 month practical training. Most of the lecturers are from universities and institutions, partners of the programme of which are New York University, INSEAD, University of Paris Dauphine and the World Bank.

The practical part of the programme is completed with a project. The actual work is ours and represents our contribution to the measurement of exchange rate risk using Value at Risk techniques.

LIST OF ABBREVIATIONS

AUD	: Australian Dollar
BIS	:Bank for International Settlements
BCGFS	:Basel Committee on Global Financial System
CAPM	:Capital Asset Pricing Model
EMBI	:Emerging Market Bond Index
EMS	:European Monetary System
EUR	:Euro
FX	:Foreign Exchange
GCB	:Ghana Commercial Bank
GHC	: Ghanaian Cedi
IVaR	: Incremental Value at Risk
JPY	: Japanese Yen
Ltd	: Limited
P&Ls	:Profits and losses
RAROC	:Risk Adjusted Return On Capital
S&P	: Standard and Poor's
USA	: United States of America
USD	:United States Dollar
VaR	: Value at Risk

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ABSTRACT

In the wake of recent failures of risk management in the financial world, there has been a widespread call for improved quantification of the financial risk incurred by firms. At the forefront of this clamour has been Value at Risk .It measures the maximum potential loss of an asset or a portfolio at a preset period and a specified confidence level, in normal market conditions.

This method became a standard by its very fast acceptance in the financial industry. It is even used as benchmark by institutions regulators like the Basel Committee which have recommended it since 1996 as an internal model, for the measurement of market risks.
The use of this standard technique to deal with exchange rate risk in a context of a continual market volatility seems to be well motivated.

We will explain the concept of value at risk and describe in detail the three methods for computing it: the parametric approach, the historical simulation, and the Monte Carlo simulation. We will discuss the advantages and disadvantages of the three methods for computing value at risk, we will deduct that the use in addition of back testing and stress testing are necessary to perform Value at risk results. Then we will illustrate it with exchange rate risk measurement, using scenarios and the case of the Ghana commercial bank portfolio .

RESUME

A la suite des récents échecs de la gestion des risques dans le monde de la finance, le besoin d'améliorer la quantification des risques financiers auxquels sont confrontées les institutions, s'est manifesté. Ainsi a été introduite la " value at risk" ou valeur exposée au risque. Elle représente la perte potentielle encourue sur un actif ou sur un portefeuille d'actifs à une période et à un degré de probabilité définie, dans des conditions normales de marché.

Cette méthode est très vite devenue standard avec son acceptation totale par les firmes financières .Elle est même une référence pour les institutions de régulation tel que le Comité de Bale qui dès 1996 la recommande aux banques pour la mesure des risques de marchés.
Son utilisation dans ce travail pour traiter du risque de change dans un contexte de continuelle volatilité des cours de change semble donc bien appropriée.

Nous expliquons le concept de la value at risk et décrivons dans les détails les trois approches de cette méthode :la méthode de la Variance-covariance, la méthode de la simulation historique et la méthode de la simulation de Monte Carlo. Nous avons discuté les avantages et les inconvénients pour les trois approches et déduit de la nécessité de compléter les mesures de la VaR avec le backtesting et le stress testing pour avoir des résultats plus fiables. Pour une bonne appréhension de ces différentes approches nous les avons illustratrées avec la mesure du risk de change suivant divers scénarios en nous appuyant sur le cas du portefeuille de la banque Ghana Commercial Bank.

GENERAL INTRODUCTION

No one country is self sufficient in all aspects of human, material and financial resources that it requires for its development. Each country depends on the outside world for the resources it lacks by transacting and trading what it has for what other countries have. However different countries have different monetary systems and different currencies. But for the purpose of international trade there should be a means of payments for goods and services from other countries. There are some currencies that are convertible and are therefore used in international transactions. The means and methods by which a country's currency is converted in terms of the currency of another country are known as foreign exchange. Foreign exchange rate is the price at which one currency is bought and sold in terms of another. It is the key link between the domestic and the world markets for goods, services and assets. Thus it is the key price of the economy. Accordingly it is widely believed that exchange rate has important implications for financial decision making and the profitability of firms .

Many countries and policy makers are aware of this role of exchange rate and accordingly make decisions. For example, one of the central motivations for the creation of the Euro was to eliminate exchange rate risk to enable European firms to operate free from the uncertainties of changes in relative prices resulting from exchange rate movements. But do changes in exchange rate have measurable effects on businesses of firms ?

An interesting literature exists on the relationship between exchange rate changes and the firm market value. Through that literature foreign exchange rate fluctuations generally affect firms and banks in particular both directly and indirectly .

The direct effect comes from banks' holdings of assets (or liabilities) with net payment streams denominated in a foreign currency. Foreign exchange rate fluctuations alter the domestic currency values of such assets. This explicit source of foreign exchange risk is easier to identify, and it is the most hedged .

The indirect sources of risk are more subtle but just as equally important. A bank without foreign assets or liabilities can be exposed to currency risk because the exchange rate can affect the profitability of its domestic banking operations. Let us this example of this indirect source of exchange rate risk generated by a credit risk. Consider the value of a bank's loan to a U.S. exporter. An appreciation of the dollar might make it more difficult for the U.S. exporter to compete against foreign firms .If the appreciation thereby diminishes the exporter's profitability, it also diminishes the probability of timely loan repayment and correspondingly, the profitability of the bank. In this case, the bank is exposed to foreign exchange risk :a stronger dollar decreases its profitability. In essence, the bank is "short" of dollars against foreign currency. Any time the value of the exchange rate is linked to foreign competition, to the demand for loans, or to other aspects of banking conditions, it will affect even domestic banks.

So to increase their profitability and performance banks and firms as well must manage this risk related to exchange rate fluctuations. But in the risk management process a key step is the risk measurement .Many methods are available to risk managers and investors to reach good results .We had some of the first methods exchange rate exposure such as economic regression approach proposed by Adler and B. Dumas , the accounting approach and the beta method.

Those methods allow to estimate the exposure at a certain level but they are mostly appropriate to corporate firms.

Traditionally there are also different risk measurements such as duration for fixed income and sensitivities. However, sensitivities are valid only for minute changes in risk factors and are inadequate for quantifying overall risk. They simply make it possible to gauge the local impact on the position's market value of a hypothetical shift in a risk factor. These traditional measures have other drawbacks. For example:

- they make it impossible to aggregate or express in a single number the risk of a position that is sensitive to different market risk factors.
- they overlook the volatility of risk factors, the interactions between these factors, and the period for which the position is supposed to be held.

To go above these limits Value at Risk seems to be appropriate. It is more recent and widely used, conveniently accepted either in financial institutions or in firms for market risks measurement. But what is value at risk concretely? How does this new tool work? And how can it be performed for good implications in the risk management process?

Value at Risk (VaR) is a coherent methodology of market risk measurement .It allows the measurement of the expected loss over a specific time interval at a given confidence level. The originality of this advocated method is not to be limited to risk measurement in terms of standard deviation ,beta or relative variation (sensitivity or delta), but to estimate an absolute potential loss, so that it can be analysed and controlled.

The main aim of our work is to provide an in-depth knowledge of the most widely used risk identification, measurement and management technique. The topic is essential for professionals involved in risk management, treasury management, financial corporate strategy as well as supervision of financial institutions .It is useful to universities and CESAG for academic purposes. Conducting this work we have also sharpened our knowledge in the field and have been familiarised with exchange rate risk measurement using VaR.

So we describe the value at risk tool, show how it works through its different methodologies and enlighten its limits to encourage practitioners to improve VaR measures with regular backtesting and well conducted stress testing as recommended by the Basel Committee .To do this we have determined Value at Risk with a simple portfolio of Ghana Commercial Bank for a risk analysis in dealing with the following topic: **measuring exchange rate risk with Value at Risk approach for a risk management decision: illustration and application.**
All the work is on the implementation of VaR through scenarios analysis .

We would like to show that this advanced tool for risk measurement is available and can be used by any financial institution or firm involved in business with transactions or financial relations with others and using traditional or modern assets.

Value at Risk measure can be used either in banks in developed countries or in those in emerging and developing ones provided that it has been well understood in all its process . We will give the necessary details to show that the process is not so complex and allow every interested manager to understand easily how it works.

To do so we have adopted a learning approach essentially based on:

- readings of several books dealing with the subject of Value at Risk , exchange rate, market risk management, and regulation working papers;
- exchange and discussion with some researchers and professionals;
- research on internet with the consultation of different web sites relating to financial; markets, exchange rate, value at risk, market risk, risk management and so on;
- a practical training at the treasury department of the GCB, using Reuters, Bloomberg and Swift .

Our work is in two parts. In the first part we have defined the Value at Risk and showed how it can embrace exchange rate risk. The second part is related to the illustration of the three methodologies, we set out the whole process of the risk measurement process with an example taken from the Australian banking system where the use of VaR is popular and where the assumptions on which the technique is based, are not always fulfilled to conduct the implementation of the parametric approach relating to the portfolio of the Ghana Commercial Bank Limited.

PART I

THEORY ON VALUE AT RISK (VaR)

Chapter 1
HISTORY AND DEFINITION OF THE TOOL

In this chapter we recount the origin of Value at Risk, and give its definition, its domain of application and its uses in risk management process, according to different sources.

I HISTORY OF VALUE AT RISK

In the early 1980s, the United States Securities and Exchange Commission (SEC) adopted a crude VaR measure for use in assessing the capital adequacy of broker-dealers trading non-exempt securities. A couple of years later, Bankers Trust implemented VaR use for the Risk Adjusted Return On Capital System (RAROC),which is a capital allocation system.
From that period up to early 1990s, a number of institutions implemented VaR measures to support capital allocation or market limits.

In the early 1990s, three events popularised Value at Risk as a practical tool for use on trading floors:

- In 1993, the Group of 30 made a groundbreaking report on derivatives practices. It was influential and helped shape the emerging field of financial risk management .It promoted the use of Value at Risk by derivatives traders and appears to be the first publication to use the phrase "Value-at-Risk".
- In 1994, JP Morgan launched its free Risk Metrics service. This was intended to promote the use of Value at Risk among the firm's institutional clients. The service comprised a technical document describing how to implement a VaR measure and a covariance matrix for several hundred key factors updated daily on the internet .
- In 1995,the Basel Committee on Banking Supervision implemented market risk capital requirements for banks. These were based upon a crude VaR measure ,but the committee also approved the use of banks' own property VaR measures in certain circumstances.

These three initiatives came in the wake of several high-profile failures of systematic risks management due to the emerging- and largely unregulated-OTC derivatives market.[1] It was also a period when a number of great organizations-including Orange County, Barings Bank and Melallgesellschaft-suffered staggering losses due to speculative trading, failed hedging programs on derivatives . Financial risk management was a priority for firms, and Value at Risk was rapidly embraced as the tool of choice for quantifying market risk. It was implemented by financial firms, corporate treasuries, commodity firms and energy firms .

Another important stimulus to the development of VaR was the move toward mark-to-market, both for cash instruments and derivatives .The common risk measure was repricing gap. As trading increased duration analysis took over, but duration's inadequacies led to the adoption of VaR.

II DEFINITION

II.1 The notion

As expressed in the general introduction Value at Risk measures the worst expected loss at a specific confidence level over a certain period of time. Value at Risk answers the question: how much can I lose with the probability X over a period of time T .[2]

Another way of expressing this is that VaR is the lowest quantile of the potential losses that can occur within a given portfolio during a specified time period .

The basic time period T and the confidence level (the quantile) q are the two major parameters that should be chosen in a way appropriate to the overall goal of risk management. The time horizon can differ from a few hours for an active desk to a year for a pension fund . When the primary goal is to satisfy external regulatory requirement ,such as bank capital requirements, the quantile is typically very small (for example,1% of worst outcomes). However for an internal risk management model used by a company to control the risk exposure, the typical number is around 5% .

[1] Over The Counter
[2] Mr. MICU, Bank for International Settlements - September 2001 presentation

The formulas for its computation depend on the numbers of assets and risk factors.
For the simple case of one asset and one risk factor, there is:

$$\mathbf{VaR} = \mathbf{A}\times\sigma\times\mathbf{C}$$

Where A is the amount of investment; σ is the volatility of the underlined asset and C the confidence level.

In the case of many assets and multiple risk factors, the formula is different and more complex. We have considered the different expressions we can have depending on the number of assets and risk factors while illustrating them, in the part two.

II.2 The domain of application

The elegance of VaR solution is that it works at multiple levels, from the position- specific micro level to the portfolio based macro level. VaR has become a common language for communication about aggregate risk taking, both within an organization and outside (e.g. with analysts ,regulators, rating agencies and shareholders).

Virtually all major financial institutions have adopted VaR as a cornerstone of a day-to-day risk measurement and more and more for long periods.

Below is an excerpt describing the use of VaR .

Statistical models of risk measurement, such as VaR allow an objective, independent assessment of how much risk is actually being taken. Chase's historical simulation methodology permits consistent and comparable measurement of risk across instruments and portfolios, irrespective of the level of aggregation. Historical simulation also makes it easy to examine VaR for any desired segment of the total portfolio and to examine that segment's contribution to total risk .VaR calculations are performed for all material trading portfolios and market risk related asset/liability management ("ALM) portfolios. Results are reported at various levels of detail by business unit and in the aggregate.
Source: Chase 1998 annual report.

The application of VaR analysis and reporting now extends to non-financial corporations. But we will develop more its use in the banking sector.

II.3 The uses of VaR in the risk management process

The estimation of the market risk of a portfolio may be important for various reasons. Measures of market risk can be used to control and manage risk bearing business activities and to allocate financial resources. Furthermore market risk measures are needed to comply with the requirements of national regulatory authorities.

VaR has been developed to give a simple or global indication of financial institutions' exposition to market risks. As a reporting tool, it gives information on risks concentration by type of markets, by traders and by financial products .

It also allows to fix negotiations limits , to allocate available capital and assess the performances of different desks of dealing rooms. Outside dealing rooms, VaR is becoming more and more popular with investment and fund managers. Also in this domain VaR allows to aggregate market risk through different types of assets but on a longer time horizon (1 month , 3 months or a year). It permits to quantify the performance of a portfolio relatively to a benchmark: this is known as relative VaR.

The Basel Committee recommends banks to hold capital against risk .In doing so the capital charge must be higher than the previous day's VaR[3].

An example of the use of VaR is as follows: *An British bank has a long position of 175 million USD, and the central bank regulators asked the bank to determine the capital required to protect against the possible market movement.*

The resolution of the above example that we will do later in part two needs the use of VaR estimation.

[3] BIS, Amendment to the capital accord to incorporate market risks –January 1996

So this single number summarises the portfolio's exposure to market risk as well as the probability of an adverse move line-dollars. Investors can then decide where to trim risk. For instance, the riskiest securities can be sold. Or derivatives such as futures and options can be added to hedge the undesirable risk. VaR also allows users to measure incremental risk, which indicates the contribution of each security to total portfolio risk.[4] Overall, it seems that VaR, or some equivalent measure, is an indispensable tool for navigating through financial markets.

Broadly VaR is used for:

- Risk reporting
- Resources allocation and investments
- Risk limits and regulatory capital requirements

[4] see related value at risk

Chapter 2
DESCRIPTION OF THE TECHNIQUE

An interesting and recent literature(mid-1990s) in the domain of risk measurement allows us to give an in-depth description of the tool through its derivatives, the main methodologies with their comparison through a discussion of each method, the shortcomings and the parameters for its analysis. In this chapter we will deal with related value at risk, Value at Risk methodologies and some specificities of these methodologies.

I RELATED VALUE AT RISK

VaR is a flexible tool for measuring risk :

- VaR can be specified for various horizons (generally between 1day and 1 month) and confidence levels (generally between 90% and 99%).
- VaR can be expressed as a percentage of market value or in absolute currency terms (e.g. U.S.D.)

There are three types of related Value at Risk measures : relative value at risk, marginal value at risk and incremental value at risk.

I.1 Relative value at risk

It measures the risk of underperformance relative to a pre-defined benchmark, such as the S&P 500 index.[5] It is relevant to many institutional investors, including investment managers and mutual funds, because their performance is often compared to a target benchmark. For example, an emerging market investment manager might have used the J.P. Morgan EMBI+index as a performance benchmark.[6] If the investment manager's portfolio rose 9% while the EMBI+index rose 10%, we would say that he underperformed his benchmark by 1% .

[5] Standard & Poor's 500 index ,see appendix 1
[6] Emerging Markets Bond Index Plus, see appendix 1

Assuming 99% confidence, a one-month relative VaR of $8 million means that on average only one time on 100 you expect to underperform your benchmark by more than $8 million due to market movements. Relative VaR is also commonly expressed as percentage of present value.

The value of the relative VaR can differ from the one of the simple VaR depending on the benchmark.

I.2 Marginal value at risk

Marginal value at risk measures how much risk a position adds to a portfolio. Specially, marginal VaR measures how much portfolio VaR would change if the positions was removed entirely(i.e., VaR with a position minus VaR without a position).

Marginal VaR is useful for measuring which position (or risk category) is the largest contributor to a portfolio risk. It can help answer the question which position to eliminate entirely in order to most effectively reduce the risk .

I.3 Incremental Value at Risk

Incremental Value at Risk is closely related to marginal Value at Risk (VaR).Marginal Value at Risk measures the difference in portfolio risk brought about by removing an entire position, whereas the incremental Value at Risk measures the impact of small change in position weighting. For example, we can estimate incremental Value at Risk by:

- increasing a position weight by 1 dollar and measuring the change in diversified portfolio Value at Risk, and
- multiplying this change by the position weighted .

Otherwise, The incremental VaR for position in a given asset A (I.VaR) is computed by the following formula:

I.VaR = VaR(portfolio with marginal position in asset A) – VaR(portfolio marginal position in asset A).

The sum of all incremental Value at Risk adds up to the total diversified portfolio Value at Risk. Therefore incremental Value at Risk may be used to calculate the percentage of contribution to risk.

One of the most common uses of incremental Value at Risk is to generate reports that rank contribution to risk hedging opportunities .Incremental Value at Risk is used to identify best candidates for gradual risk reduction (i.e., where the question is not what position to unwind entirely but rather which position to partially hedge).
For example, an asset manager discovers that a position engenders an excessive VaR, he will be pushed to find the best way of reducing that number. Incremental VaR, on the other hand, allows him to X-ray the position and identify the contribution made by each asset to total VaR. The ultimate aim is to make VaR an active management tool rather than simply a supervisory instrument.

The following Chart 1, taken from Riskmetrics technical document shows the difference between VaR and the incremental VaR in each region of the world.
We can notice that the region that has the largest VaR (Asia ex- Japan) is not the one that has the largest Incremental VaR (U.S.). The comments of the chart 2 give more details.

Chart 1: VaR vs Incremental VaR

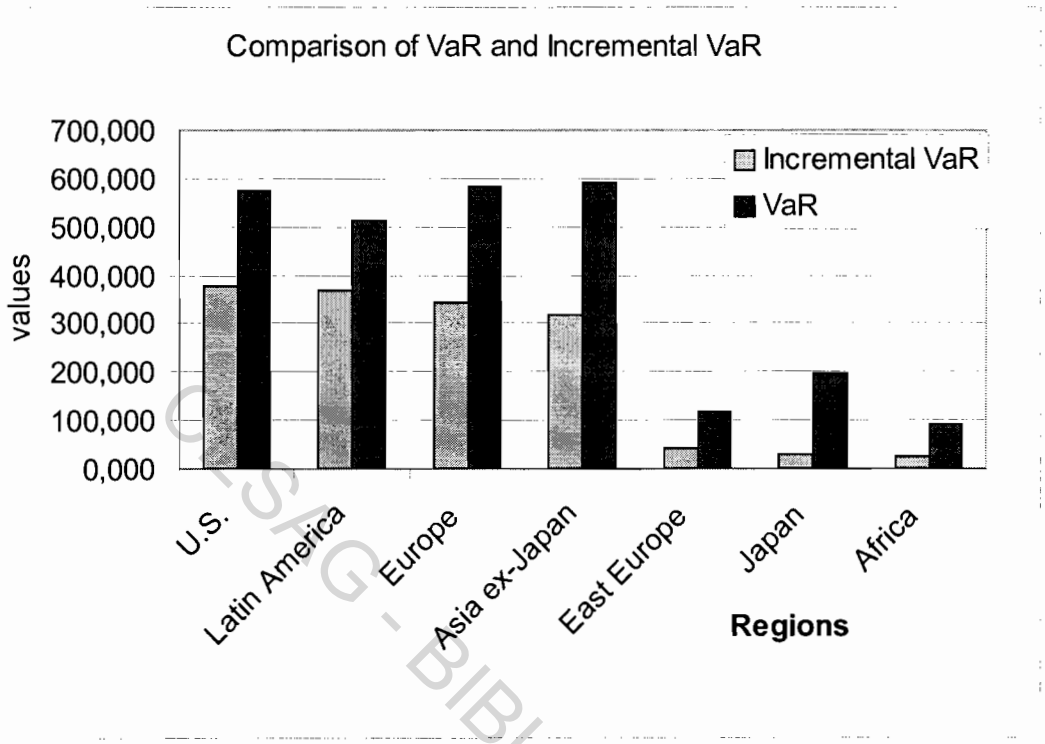
Risk Contribution Report	Present Value	VaR	Marginal VaR	Incremental VaR	Contribution to Risk
U.S.	71,774,216	574,194	222,075	378,341	25%
Latin America	10,258,887	512,944	220,114	369,626	25%
Europe	64,600,480	581,404	204,358	343,237	23%
Asia ex-Japan	12,693,840	589,734	196,046	317,346	21%
East Europe	1,948,860	116,932	31,05	40,322	3%
Japan	19,569,450	195,694	48,012	30,068	2%
Africa	4,669,370	93,387	24,423	24,163	2%
Divers. Benefit		(1,161,186)			
Aggregate	185,515,103	1,503,103		1,503,103	100%

source : *J.P. Morgan Risk Metrics technical document*

Asia ex- Japan is Asia excluded Japan

For a better comparison , we have drawn the chart 2 at the next page.

Chart 2: Graphical comparison of VaR and IVaR



Comments:

- Even though Asia ex-Japan is the largest single relative VaR position, it is only the fourth largest contributor to risk, as measured by the percentage of incremental VaR(21%). The best three opportunities for reducing risk through hedges lie in U.S., Latin America, and Europe.
- VaR refers to 95% worst-case loss over 1 day due to adverse movements in market rates.
- Diversification Benefit is equal to diversified (aggregate) VaR minus the sum of all individual VaRs. It measures the risk reduction achieved through diversification (i.e. correlation being lower than 1) between categories.

II VALUE AT RISK METHODOLOGIES

Market risk models are designed to measure potential losses due to adverse changes in the prices of financial instruments. There are several approaches to forecasting market risk, and

no single method is best for every situation. Over the last decade, Value-at-Risk (VaR) models have been implemented throughout the financial industry and by non-financial corporations as well . Inspired by the modern portfolio theory, VaR models forecast risk by analysing historical movements of market variables. To calculate VaR, one can choose from three main methods: *parametric*, *historical simulation*, and *Monte Carlo simulation*. Each method has its strengths and weaknesses, and together they give a more comprehensive perspective of risk.

Before defining these three approaches for calculating VaR, we shall explain linear and non-linear instruments. A financial instrument is said to be non-linear when its price changes disproportionately relative to a movement in the underlying asset. The risk of nonlinear instruments(e.g., options) is more complex to estimate than the risk of linear instruments (e.g., traditional stocks, bonds, swaps, forwards, and futures). To account for the discontinuous payoff of nonlinear instruments like options, risk simulations should use full valuation formulas (e.g., Black-Scholes) rather than first order sensitivities (e.g., delta).

II.1 The Parametric approach of VaR

The parametric VaR assumes a normal probability distribution. The changes in the instrument values are assumed to be linear with respect to the changes in risk factors. The primary advantage of this approach is that it is fast and computationally simple to calculate. This facilitates the calculation of VaR on portfolios with many different assets and risk factors. But the Parametric VaR assumes that returns are linearly related to risk factor returns and that the risk factor returns are assumed to be normally distributed. Thus it ignores the non-linear price sensitivities. So this method may underestimate potential future portfolio volatility.

II.2 The Historical simulation method of VaR

The historical method identifies a portfolio's exposure to specific market factors and calculates (say daily) observed changes in these market factors over the time horizon (say 100days) to be used in VaR calculation. The portfolio is then revalued as if each change occurred from today's levels, thus creating 100 possible changes to the portfolio's value.

From these figures, a VaR number corresponding to a given confidence level is determined. This method is relatively simple to implement if historical data is easily available. By relying on actual prices, the method allows non-linearity and non-normal distributions. It does not rely on specific assumptions about valuation models, it is not prone to model risk.
However, the historical simulation method uses only one sample path (i.e. the actual past). It also assumes that the past represents fairly the immediate future. This method may lack situations with temporarily elevated volatility. Furthermore, the method puts the same weight on all the observations in the window, including old data points. Thus, the measure of risk can change significantly after an old observation is dropped from the window. The Historical simulation becomes very cumbersome for large portfolios with complicated structures.

II.3 The Monte Carlo Simulation method of VaR

In the Monte Carlo simulation, a number of scenarios are constructed to represent possible future financial market outcomes. In each trial or scenario, an independent random number for each of the market factors is selected from a particular distribution. These random moves are constrained to reflect historical market volatility and correlation. The portfolio is then valued under each of these scenarios. From these values, a VaR number corresponding to a given confidence level can be determined.

The Monte Carlo simulation is by far the most powerful method to compute VaR. It can account for a wide range of risks including the non-linear price risk, the volatility risk, etc. It can also incorporate time variation in volatility, fat tails, and extreme scenarios.

However, the biggest drawback of this method is the computational cost. When full valuation of assets is complex, this method quickly becomes too onerous to implement on a frequent basis . It also relies on a specific stochastic model for underlying risk factors as well as pricing models for securities such as options and mortgages.

The following table gives a summarised description of the three main methodologies for calculating VaR.

Chart 3 :description of the three main methodologies of VaR.

Methodology	Description	Applications
Parametric	Estimates VaR with equation that specifies parameters such as volatility, correlation, delta and gamma;	Accurate for traditional assets and linear derivatives, but less accurate for non-linear derivatives;
Historical simulation	Estimates VaR by simulating random scenarios and revaluing positions in the portfolio;	Appropriate for all types of instruments, linear and non-linear.
Monte Carlo simulation	Estimates VaR by reliving history; takes actual historical rates and revalues positions for each change in the market .	

It can be observed that the Monte Carlo and historical simulations are mechanically identical in that they both revalue instruments, given changes in market rates. The difference lies in how they generate scenarios, whereas the historical simulation takes actual past market movements as scenarios.

From an end-user perspective, the important point to remember is that if you have significant non-linear exposures in your portfolio, a simulation approach with full position re-pricing will generally be more accurate than a parametric approximation for estimating the VaR.

III SOME SPECIFITIES OF THE METHODOLOGIES

For a better understanding of the methodologies here are some of their important particularities .We also try to clarify the obvious question that is: which method of calculating Value at Risk is the best ? Because there is no clear answer. In fact, the methods differ in their ability to capture risk, ease of implementation, facility of explanation to senior

management, flexibility in analysing the effect of changes in the assumptions, and reliability of the results. The best choice will be determined by the dimensions the risk manager finds most important. Below we discuss how the three methods differ on these dimensions.

The choice of not using Value at Risk methods at all can be a justified decision . In fact non-financial corporations might find that value at risk's focus on mark-to-market profit or loss over a holding period of *t* days doesn't match their perspective. Instead, they may be more interested in the distributions of quarterly cash flow over the next perhaps 20 quarters, and how these distributions are affected by transactions in financial instruments. This suggests a "cash flow at risk" measure, which is an estimation of the value of future cash flow that is supposed to be at risk in normal market conditions, companies exposed to only a few different market factors may find simple sensitivity analyses to be adequate.

But as mentioned since the introduction, VaR use in the financial industry is more and more developed and diversely satisfactory.

III.1 Ability to capture risk

The three simulation methods are effective depending on the type of instrument to deal with.

Variance-covariance method works well for instruments and portfolios with traditional assets content but is less able to capture the risks of modern derivatives instruments than the two simulation methods. The limitation of Variance-covariance method is that it incorporates options by replacing them with or mapping them to their "delta-equivalent" spot positions. This amounts to linearizing the options positions, or replacing the non-linear functions that give their values in terms of the underlying rates and prices with linear approximations. For instruments or portfolios with a great deal of non-linear instruments content, the linear approximations may not adequately capture how the values of the instruments change with changes in the underlying rates and prices.

In Variance-covariance method, the problem of adequately capturing the risks of options and option-like instruments is least severe when the holding period is short (e.g. one day t=1). Large changes in the underlying rates or prices are unlikely over such a short holding period,

and the linear approximation in this method works well for small changes in the underlying rates and prices.

As a result, Variance-covariance method works well even for positions with moderate options content provided the holding period is short. However, over longer holding periods, for example two weeks or one month, larger changes in underlying rates and prices are likely to affect the portfolio and Value at Risk estimates produced using Variance-covariance method cannot be relied upon for positions with moderate or significant options content.

The simulation methods (historical and Monte Carlo) work well regardless of the presence of options in the portfolio because they recompute the value of the portfolio for each change of the basic market factors. In doing so, they estimate the "correct" distribution of portfolio value, though this statement must be qualified. The distribution of portfolio value generated by the Monte Carlo simulation depends on the assumed statistical distribution of the basic market factors and the estimates of its parameters, both of which can be "wrong" and therefore may lead to errors in the calculated value at risk. Similarly, the distribution of portfolio value generated by the historical simulation will be misleading if the prior *N* days from which the historical sample was drawn were not representative.

A final risk measurement issue related to options and option-like instruments is the ability of Value at Risk methodologies to incorporate the fact that option volatilities are random and option prices change with changes in volatilities. As indicated earlier, Variance-covariance method also does not capture these features of options adequately. In contrast, the Monte Carlo simulation can normally incorporate, the facts that volatilities are random and option prices change with volatilities by extending the simulation to include a distribution of volatilities, though this is not typically done in actual implementation of this methodology. Historical simulation also can incorporate changes in option prices with changes in volatilities if option volatilities are included as additional factors and collected for the *N* day period used in the simulation.

III.2 Ease of implementation

The historical simulation method is easy to implement for portfolios restricted to currencies for with data on the past values of the basic market faetors are available. It is conceptually simple, and can he implemented in a spreadsheet beeause pricing models for financial products are now available as spreadsheet add-in functions. The principal difficulty in implementing historical simulation is that it requires from the user to possess a time scries of the relevant market factors covering the last *N* days or other periods. This can pose a problem for multinational companies with operations and local currency borrowings in many countries, or with receivables and other instruments in a wide range of currencies. While spot exchange rates are readily available for virtually all currencies, obtaining reliable daily market interest rates for a range of maturities in some currencies without well developed capital markets can be difficult.

A range of vendors offer softwares that compute value at risk estimates using Variance-covariance method, so this method is very easy to implement for portfolios restricted to currencies and types of instruments covered by the available systems. Variance-covariance method can be moderately difficult to implement for portfolios which include currencies and types of instruments not covered by the available systems. First, estimates of the standard deviations and correlations of the market factors are required. Computing these estimates is straightforward if data are available, but as indicated above reliable market interest rates may not be available for a range of maturities in all currencies. Seeondly, and more difficult, instruments must be mapped to the delta-equivalent positions .

"Off the shelf" software is poised to become available for the Monte Carlo simulation method, making it as easy to implement as Variance-covariance method for portfolios covered by the available systems. One difference is that eomputation times will be longer with the Monte Carlo simulation. For portfolios not covered by the existing software, the Monte Carlo simulation is in some ways easier, and in some ways more difficult, than Variance/covariance method. It is easier because it is not necessary to map instruments onto the standard positions, and it is more difficult because the user has to select the distribution from which the pseudo-

random vectors are drawn, and select or estimate the parameters of that distribution. Actually carrying out the simulation is not difficult because pseudo-random number generators are available as spreadsheet add-ins. However, selecting the distribution and selecting or estimating the parameters requires high degrees of expertise and judgment. Another disadvantage of the Monte Carlo simulation is that for large portfolios the computations can be time-consuming.

All the three methods require that pricing models be available for all instruments in the portfolio. While Variance/covariance method is the easiest to implement for traditional instruments; But it does not directly make use of instruments' prices, options are mapped to their "delta-equivalent" positions, and the computation of deltas requires pricing models. The need for pricing models can pose a problem for portfolios which included certain exotic options and currency swaps with complex embedded options.

III.3 Ease of communication with senior management

The conceptual simplicity of historical simulation makes it the easiest to explain to senior management. Variance-covariance method is difficult to explain to an audience without technical training because the key step, the reliance on the mathematics of the Normal distribution to calculate the portfolio standard deviation and Value at Risk, is simply a black box. The Monte Carlo simulation is even more difficult to explain. The key steps of choosing a statistical distribution to represent changes in the market factors and engaging in pseudo-random sampling from that distribution are simply alien to most people.

III.4 Reliability of the results

All the methods rely on historical data. The Historical simulation is unique, though, in that it relies so directly on historical data. A danger in this is that the price and rate changes over last 75 (or 250) days is that the last 175 (or 250) days might not be typical. For example, if by chance the last 175 days were a period of low volatility in market rates and prices, Value at Risk computed using historical simulation would understate the risk in the portfolio. Alternatively, if by chance the U.S. dollar price of the CFA Franc rose steadily over the last

175 days and there were relatively few days on which the dollar price of a CFA Franc fell, Value at Risk computed using historical simulation would indicate that long positions in the CFA Franc involved little risk of loss. Moreover, one cannot be confident that errors of this sort will "average out." Traders will know whether the actual price changes over the last 175 days were typical, and therefore will know for which positions Value at Risk is underestimated, and for which it is overestimated. If Value at Risk is used to set risk or position limits, the traders can exploit their knowledge of the biases in Value at Risk system and expose the institution to more risk than the risk management committee intended.

Other methodologies use historical data to estimate the parameters of distributions (for example Variance-covariance methodology relies on historical data to estimate the standard deviations and correlations of a multivariate Normal distribution of changes in market factors for which the means are assumed to be zero), and are also subject to the problem that the historical period used might be atypical. However, assuming a particular distribution inherently limits the possible shapes that the estimated distribution can have. For example, if one assumed that the changes in the U.S. dollar price of a CFA Franc followed a Normal distribution with a mean of zero, one would predict that there was a 50 percent chance that the price of a CFA Franc would fall tomorrow even if the price had risen on each of the last 175 days. Since theoretical reasoning indicates that the probability that the price of the CFA Franc will fall tomorrow is about 50 percent, regardless of what it has done over the past 175 days, this is likely a better prediction than the implicit prediction in historical simulation.

Variance-covariance and Monte Carlo simulation methods share a different potential problem: the assumed distributions might not adequately describe the actual distributions of the market factors. Typically, actual distribution of changes in market rates and prices have "fat tails" relative to the Normal distribution. That is, there are more occurrences away from the mean than predicted by a Normal distribution. Nonetheless, the Normal distribution assumed in Variance-covariance method appears to be a reasonable approximation for the purposes of computing Value at Risk. An issue unique to the Monte Carlo simulation method stems from the fact that the designer of the system can choose the statistical distribution to use for the market factors. This flexibility allows the designer of the system to make a bad choice, in the

sense that the chosen distribution might not adequately approximate the actual distribution of the market factors.

Concerns about the reliability of the methods can be partially addressed by comparing actual changes in value to Value at Risk amounts. This sort of validation is feasible because Value at Risk approach explicitly specifies the probability with which actual losses will exceed Value at Risk amount. It is performed by collecting a sample of value at risk amounts and actual mark-to-market portfolio profits and losses, and answering two questions. First, does the distribution of actual mark-to-market profits and losses appear similar to the distribution used to determine Value at Risk amount? And second, do the actual losses exceed Value at Risk amount with the expected frequency? A limitation of this approach to validation is that chance occurrences will almost always cause the distribution of actual portfolio profits and losses to differ somewhat from the expected distribution. Because of this, reliable inferences about the quality of Value at Risk estimates can only be made by comparing relatively large samples of value at risk amounts and actual changes in portfolio values. If validation of this sort is considered essential a short holding period must be used in computing Value at Risk amounts, because it will take many years to collect a large sample of monthly or quarterly value at risk amounts and portfolio profits and losses.

III .5 Flexibility in incorporating alternative assumptions

In some situations the risk manager will be right to think that the historical standard deviations and/or correlations are not reasonable estimates of the future ones. For example, in the period immediately prior to the departure of the British pound from the European Monetary System (EMS) in September 1992, the historical correlation between changes in the dollar/pound and dollar/mark exchange rates was very high. Yet a risk manager might have suspected that the pound would leave the EMS, and therefore that the correlation would be much lower in the future. How easily could he have calculated Value at Risk in this ambiguous and speculating situation of "what-if" scenario using each of the three methods?
The Historical simulation is directly tied to the historical changes in the basic market factors. As a result, there is no natural way to perform this sort of "what-if" analysis. In contrast, it is very easy to carry out this sort of "what-if" analysis in Variance-covariance and Monte Carlo simulation methods. In these, the historical data are used to estimate the parameters of the

statistical distribution of changes in the market factors. The user may override the historieal estimates, and use any consistent set of parameters chosen. The only constraint is that the user interfaces in some software implementations of the methods may make this cumbersome.

As a result all the three approaches for estimating VaR have something to offer and can he used depending on the characteristics, together or alternatively to provide a more robust estimate of VaR.

Each of the aforementioned methods are best adapted to a different environment .

Philippe JORION (1997) concluded that :[7]

- for large portfolios where optionality is not a dominant factor, the Delta-normal method provides a fast and efficient method for measuring VaR.[8]
- for portfolios exposed to a few sources of risk and with substantial option components the Delta-Gamma method provides increased precision at a low computational cost. [9] However, the method tends to perform well only when the Greeks of the options are stable. It does not perform well for options which are near maturity or at the money.
- for portfolios with substantial option components (such as mortgages), a full valuation method such as the Monte Carlo simulation is needed.

For example, a parametric approach may be used for instant risk measurement during a trading day for non-linear instruments and more for linear ones, while a simulation approach may be used to provide a fuller Pieture of Risk by the end of the trading day.

As a conclusion, we can say that the choice of the methodology depends on the portfolio, that is why the Basel Committee requires backtesting to see the more adapted method for each portfolio . Besides, stress testing is recommended to prevent extreme cases like crises. We will give the methodologies for these useful complements to VaR in the second part.

[7] Philippe JORION (1997), VaR the new benchmark for controlling markets risk

[8] This method is the variance covariance approaeh in the case linear assets

[9] This method is the extent of parametric approach when the assets are not linear

We can summarise this part, by pointing out that there are many advantages of using VaR models. When calculated at the corporate level, it summarizes the overall risk across all the bank's trading activities into a single number for senior management .
Since VaR is denominated in currency units and is linked to a confidence level, it provides a consistent and comparable measure of risk across all instruments, products and business .

But VaR does have some limitations. VaR rests on models volatilities and co-movements of risk factors. It offers little guidance probability. This limitation may be overcome by using stress to examine the implementations when the abnormal, unexpected worst-case scenario materializes.

PART II

VALUE AT RISK ESTIMATION AND EXAMPLE OF ITS APPLICATION TO THE GHANA COMMERCIAL BANK

Chapter 1

PARAMETERS FOR VALUE AT RISK ESTIMATION AND ANALYSIS

Before the estimation of Value ate Risk, we will explain the parameters and the notions of market risks necessary for the determination and the analysis of the different results .

Estimating a good VaR, that reflects the reality is also related to the choice of the parameters necessary for calculation and analysis. We discuss below these parameters.

I PARAMETERS

I.1 The confidence level

We first choose a confidence level or probability of loss associated with VaR measurement. Confidence levels generally range between 90% and 99%. Most banks assume 95% confidence as a baseline, but gives users the flexibility to choose other levels. Rather than choosing a single parameter, some firms use several confidence levels (e.g., 95% and 99%)and forecast horizons (e.g., 1 day and 1 year).

I.1.1 The choice of the confidence level

There is nothing magical about confidence levels. In choosing confidence levels for market risks, companies should consider worst-case loss amounts that are large enough to be materialized, but that occurs frequently enough to be observable. For example, with a 95% confidence level, losses should exceed the VaR about once a month (or once in 20 trading days), giving this risk statistic a visceral meaning. Risk takers are thus encouraged to compare their daily P&Ls against their VaR and consider return on risk.

Some maintain that using a higher level of confidence, such as 99.9%, would be more conservative. One might also argue, however, that a higher confidence level can lead to a false sense of security. A 99.9% VaR will not be understood as well or taken as seriously by

risk takers and managers because losses will rarely exceed that level (we expect a loss of that magnitude to occur about onee in four years). Furthermore, due to fat-tailed market returns, a high confidence level VaR is difficult to model and verify statistically. VaR models tend to lose accuracy after the 95% mark and certainly beyond 99%. We can't rely on models to do all the "thinking" for us. Beyond a certain confidence level, rigorous stress testing becomes more important than statistical analysis. The choice of the confidence level is related to means taken to manage the remaining percentage. Example the choice of 95% confidence level at J.P. Morgan goes back to former CEO Dennis Weatherstone, who reputedly said, "VaR gets me to 95% confidence. I pay my risk managers good salaries to look after the remaining 5%."

However, the confidence level is inversely linked to the risk. A daily VAR of $10 million at 99% confidence interval means that the firm could lose/gain up to $10 million on 99 out of 100 trading days. Intuitively, the firm with a daily VAR of $10 million at 99 % confidence interval has a 'less risky' portfolio than the one with a daily VAR of $10 million at 95 % confidence.

1.2 Forecast horizon

According to Professor Philippe JORION, the horizon must be related to the liquidity of the assets, or the time necessary for an orderly liquidation (which depends on the size of the fund). Alternatively, the horizon should cover the time necessary to raise additional funds or for corrective action. This explains why the Basel committee has chosen a high confidence level of 99% and 10-day horizon to determine the minimum capital level for the commercial banks.

But in practice, generally, active financial institutions (e.g., banks, hedge funds) consistently use a 1-day forecast horizon for VaR analysis of all market risk positions. For banks, it simply doesn't make sense to project market risks much further because trading positions can dynamically change from one day to the next. On the other hand, investment managers often use a 1-month forecast window, while corporations may apply quarterly or even annual projections risk.

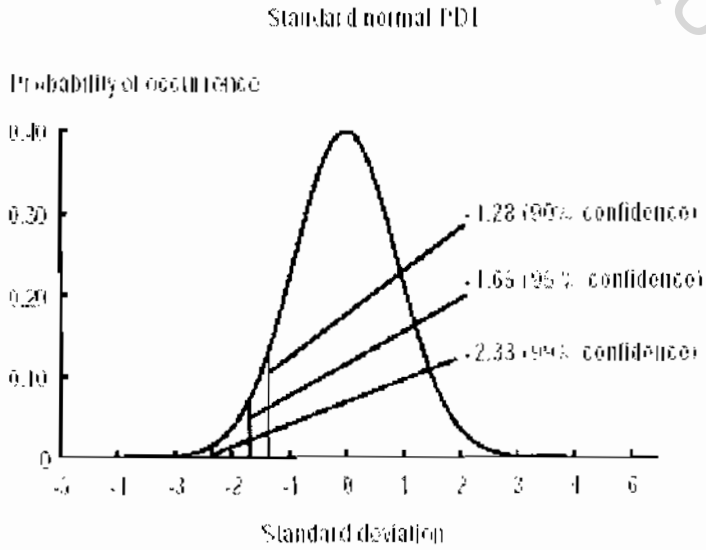
I.3 Base currency

The base currency for calculating VaR is typically the currency of equity capital and reporting currency of a company. For example, Bank of France would use the euro (EUR) to calculate and report its worldwide risks, while the Rand Merchant Bank of South Africa would use the Rand (ZAR).

I.4 Confidential level scaling factors

Standard deviations can be used to estimate lower-tail probabilities of loss when the parametric approach to measuring risk is used. Lower-tail probability of loss refers to the chance of loss exceeding a specified amount.

Chart 4: illustration of confidence level



Because returns tend to cluster around the mean, larger standard deviation moves have lower probability of occurring. To get the tail probability of loss levels and implied VaR confidence level, we use standard deviation (confidence level scaling factors). This chart shows three confidence levels scaling factors and their associated tail probabilities of loss levels.

I.5 Time scaling of volatility

We know that risk increases with time: the longer we hold a position, the greater the potential loss is. But unlike expected returns, volatility does not increase linearly with time. Long-horizon forecasting is complicated due to trending, autocorrelation, mean reversion of market returns, and the interrelationship of many macroeconomic factors. Autocorrelation refers to correlation between successive-days' returns, and mean reversion is the tendency for time series to revert to a long-term average (this is observed especially for interest rates).

We may need to time scale VaR estimates, for example when converting a daily VaR to a 10-day horizon regulatory VaR standard. A commonly used method is the square root of time scaling, which roughly extrapolates 1-day volatilities as well as 1-day VaR to longer horizons. The method assumes that daily price moves are independent of each other, and that there is no reversion, trending, or autocorrelation in markets. It is worthy to note that we use the number of trading days, as opposed to actual days to scale volatility (5 trading days per week, and 21 days per month).

For example,

- Weekly volatility = daily volatility $\times\sqrt{5}$
  = daily volatility$\times$2.24
- Monthly VaR = 1-day VaR $\times\sqrt{21}$
  = 1-day VaR $\times$4.58

That means if a bank has a weekly VaR of £1 million, a monthly value would he £ 4 580 000 for a chosen confidence level.

The main target of VaR is to measure market risks, so it is important to have an idea , even more, a better understanding of what the market in general and the exchange rate risk in particular are.

II THE NOTION OF MARKET RISK

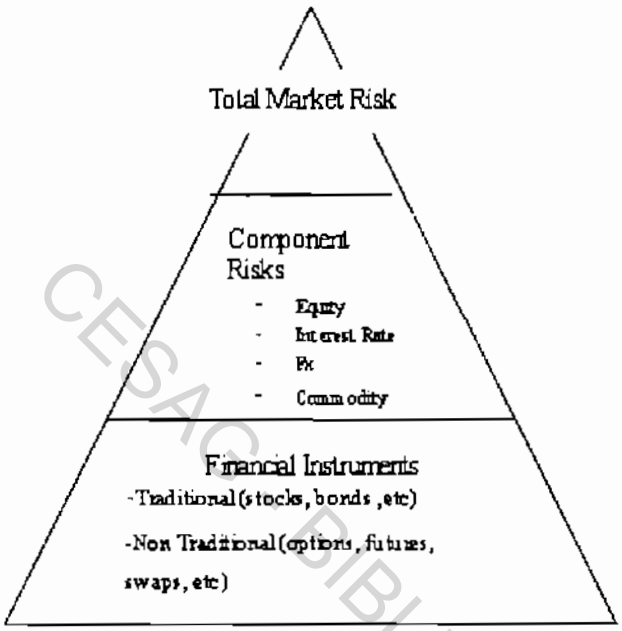
II.1 Definition of market risk

Market risk is the risk resulting from adverse price or volatility moves of the assets contained in a firm's portfolio. It is different from the firm's mark-to-market, which is the current value of the firm's volatility change.

The BIS defines market risk as "the risk that the value of on- or off-balance-sheet positions will be adversely affected by movements in equity and interest rate markets, currency exchange rates and commodity prices." The main components of market risk are therefore equity, interest rate, FX, and commodity risk.

The chart 5 at the next page gives a global view of total risk.

Chart 5: component of market risks



- At the top of the pyramid we have total Market Risk, which is the aggregate of all component Risks;
- In the middle of the pyramid, we see how financial instruments are driven by the underlined components;
- A the lowest level Market risk arises from fluctuation prices of financial instruments.

Source : risk management

Residual risks: In addition to market risk, the price of financial instruments may be influenced by the following residual risks: spread risk, basis risk, specific risk, and volatility risk.

Spread risk is the potential loss due to changes in spreads between two instruments. For example, there is a credit spread risk between corporate and government bonds.

Basis risk is the potential loss due to pricing differences between equivalent instruments, such as futures, bonds and swaps.[10] Hedged portfolios are often exposed to basis risk.

Specific risk refers to issuer specific risk, e.g., the risk of holding Yahoo! stock vs. an S&P 500 futures contract. How to best manage specific risk is a topic of debate. We can observe that according to the Capital Asset Pricing Model (CAPM),specific risk is entirely diversifiable.

Volatility risk is defined as potential loss due to fluctuations in implied option[11] volatilities[12] and is often referred to as "vega risk".[13] Short option positions generally lose money when volatility spikes upward.

To determine the total price risk of financial instruments, we aggregate market risk with residual risk:

Total Price risk = Market Risk + Residual Risk

All these risks are important and have variable effects on investments assets, portfolios and business of firms, but especially the exchange rate risk attracts our attention here.

III FOREIGN EXCHANGE RISK

The exchange rate risk is the risk that faces an investor, a bank or an institution, possessing a portfolio of assets denominated in a currency different from ,the one to invest in or the local one. Otherwise, it is the risk that a business' operations or investment's value will be affected

[10] A swap is an exchange of streams of payments over time according to specified terms. The most common type is an interest rate swap, in which one in return for receiving a adjustable rate from another party.

[11] Option gives the buyer or holder the right , but not the obligation, to buy or sell an underlying financial asset or commodity.

[12] Volatility is the relative rate at which price of a security moves up or down. If the price of a stock moves up and down rapidly over short time periods, it has high volatility. If the price almost never changes, it has low volatility.

[13] Vega is the measure of change in the value of the option compared with a change in volatility.

by changes in exchange rates. For example, if money must be converted into a different currency to make a certain investment when the money is converted back. This risk usually affects businesses, but it can also affect individual investors who makes international investments. It is also called currency risk.

Example: Long position of USD 1 million with 1USD = 710 F CFA. If the USD falls to 680 F CFA, then the loss will be 1000 000 (680-710) = – 30 000 000 F CFA.

The notion of position

The level of exposure of an investor or firm to exchange risk is determined by the notion of position.

The position of an investor or a bank on an asset is the quantity of this asset the investor or bank has, will receive that has been brought or to be delivered. It is determined as followed:

Position on an asset = Quantity of assets detained + Quantity of assets to receive or to sell – Quantity of assets to deliver or to buy.

The economic agents can have three types of position:

- a square and null position if it is equal to 0
- a opened and long position if it is superior to 0
- a opened and short position if it is inferior to 0

To determine the level of risk on an asset or a portfolio will have to calculate the position on this asset or the position of each asset of the portfolio.

In the risk measurement process with value at risk methods, the determination of the position and the exposure are necessary.

Chapter 2
ILLUSTRATION OF THE METHODOLOGIES FOR VaR ESTIMATION

I VAR CALCULATION FOR A PORTFOLIO OF A SINGLE ASSET AND ONE RISK FACTOR

The method of computing the Value at risk depends on the composition of the assets and the risk factors in the portfolio. It is not the same way of calculation when the portfolio contains a single asset of one risk factor and if it contains more than one asset and risk factors.
Example of a portfolio of one asset VaR computation:

A Spanish bank has a long position of 150 million USD, and the central bank regulators asked the bank to determine the capital required to protect against the possible adverse market movements . The risk analyst has to evaluate the possible loss over 10 days interval, in order to set the capital ratio for this position;
Knowing that the exchange rate on that date is EUR/USD=1.20, and the historical volatility on the last 250 days is 2.25%.

Solution
We first define the exposure of the Euro position
The risk factor here is the exchange rate volatility

- *Exposure =150 mil×1.20 EUR/USD*
  =180 mil. EUR
- *Confidence level setting 95%,*
  X=1.65
- *Determination of the risk*
  FX risk = 180mil×1.65×0.025
  FX risk =15846663.75 EUR

As a conclusion we infer that the maximum loss of the exposure is not higher than 15846663.75 EUR. However VaR calculations are highly sensitive to the volatility of the EUR/USD volatility measure.

II VAR CALCULATION FOR A PORTFOLIO OF MULTIPLE RISK FACTORS

Let us consider the following example inspired from the Risk Metrics technical document.

A Swiss bank has 100 mil. USD long position in US Treasury bonds. The general manager is concerned about the evolution of the yield curve in the United States and of the exchange rate CHF/USD. He wants to set a limit for the risk generated by this exposure to 1 mil. CHF, and asks the risk analyst to evaluate the maximum loss over 1 day interval with 95% statistical confidence. To what amount this exposure has to be reduced in order to bound the daily maximum loss risk to 1 mil. CHF?
Here the portfolio is composed of one asset (US Treasury bands) and 2 risk factors (the bonds volatility and CHF/USD volatility).

To solve this case we still use the general simple formula, hut here we need to determine an aggregate volatility for the two risk factors which are the evolution of the yield curve and the exchange rate. The formula of the aggregate volatility is given by:

$$\sigma_{VaR} = \sqrt{\sigma^{2}_{\Delta Bp} + \sigma^{2}_{\Delta FX} + 2 \times \rho_{\Delta Bp, \Delta FX} \times \sigma_{\Delta Bp} \times \sigma_{\Delta FX}}$$

Where $\sigma_{\Delta Bp}$ is the volatility of the bond, $\sigma_{\Delta FX}$ is the volatility of the exchange rate and $\rho_{\Delta FX, \Delta Bp}$ the correlation between the two risk factors .

Solution

The first step is to define the exposure

Exposure =100 mil. USD x 1.70 EUR/USD = 170 mil CHF

The following step calculate the volatility

Historical volatility US Treasury bonds = 0.45%

Historical volatility CHF/USD = 0.26%

Correlation coefficient between the changes in bond price and the exchange rate changes = -0.6

Set the confidence interval

a) 95% ; N(X)=1-0.95; X=1.65

Where X is the number of standard deviations

Calculate the risk for this exposure

b) $\sigma_{VaR} = 0.003601$

Maximum loss = 170 mil x 1.65 x 0.003601= 1 010 190

Exposure for one million maximum loss

1000 000 = 168 285 256 x 1.65 x 0.003601

The exposure has to be reduced with 1714744 CHF (170 000 000- 168 285 256).

Source : Bank for International Settlements, September 2001 presentation

III ILLUSTRATION OF THE THREE APPROACHES IN THE CASE OF TWO ASSETS

When the portfolio is composed of more than one asset, VaR calculation is more complex than the case of one asset.

To see and understand how the three methodologies of Value at Risk work in the case of portfolios with more than one instrument, we have chosen an example whose calculations are already done . The scenario is related to the Australian banking industry, because the three methodologies are familiarly used in most of the banks to control market risks.

Moreover, Australia is a emerging country and is therefore a good example for our study. So we took the charts and the results of a motivated study of the federal reserve of Australia to explain the illustration of the three methodologies.
In fact the daily distribution of this example behaves approximately like the one we will create for our case in chapter 3 of this section.

For a basic level and in line with our topic of measuring exchange rate risk with VaR approach, a simple portfolio of two spot foreign-exchange positions can be used to illustrate three of the most common approaches to VaR calculation. A one-day holding period is assumed and VaR is defined in terms of both 95th and 99th percentile confidence levels.

The portfolio example consists of a spot long position in Japanese Yen and a spot short position in US dollar . Thus the value of the portfolio will be affected by movements in the JPY/AUD and USD/AUD exchange rates.

Table 1: Portfolio of the Two Positions (JPY and USD)

Position 1	100 000	JPY long
Position 2	-10 000	USD short

The estimate of a VaR figure is based on the historical behaviour of those market prices that affect the value of the portfolio. In line with the Basel Committee's requirements 250 days of historical data are used, from 9th June 1995 to 5th June 1996, to perform VaR calculations below.[14]
Charts 6 and 7 below are histograms of the daily returns for the JPY/AUD and USD/AUD exchange rates. The smooth line in each chart represents a normal distribution with the same mean and standard deviation as the data. In both upper and lower tails of each series, the actual frequency of returns is greater than that which would be expected if returns were normally distributed (that is, the observed distributions of daily returns have 'fatter tails' than implied by the normal distribution). Thus both series of daily returns appear more likely to be

[14] The daily observations are available on the reserve bank of Australia (www.rba.gov)

samples drawn from some distribution other than a normal distribution (such as a t-distribution).

The starting point of all the three VaR approaches is to revalue the portfolio at current market prices.

Chart 6: Distribution of daily returns in JPY/AUD exchange rate

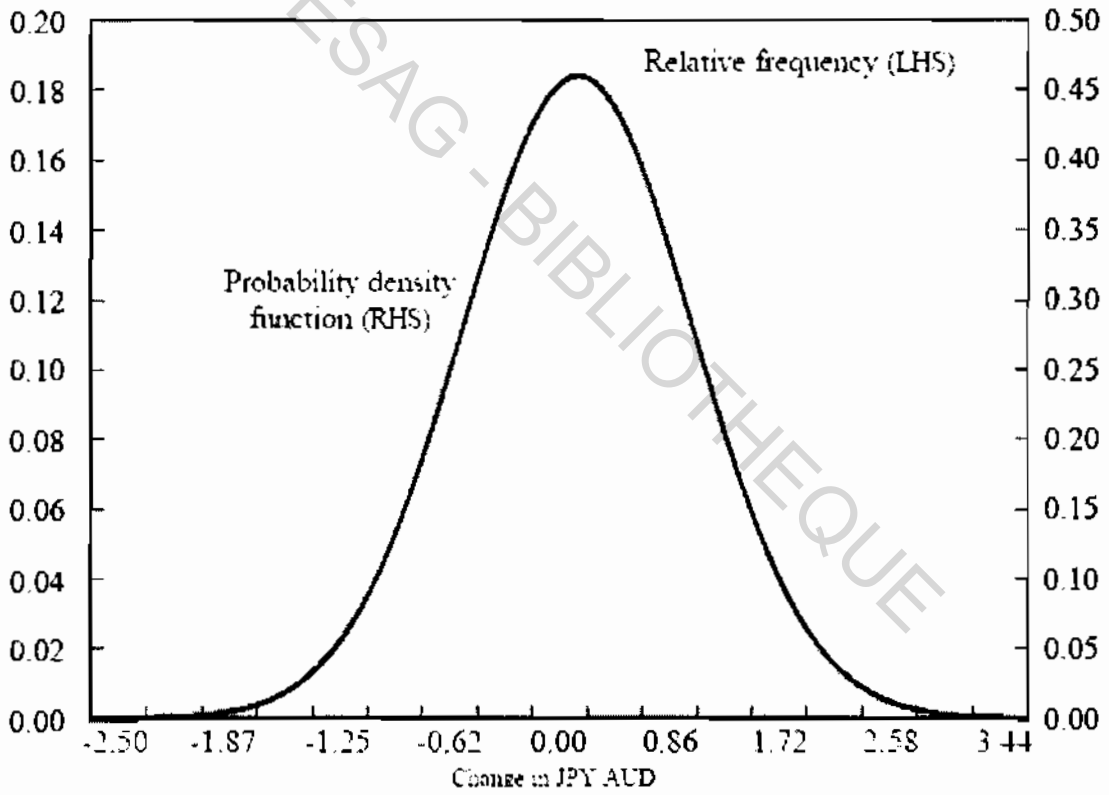
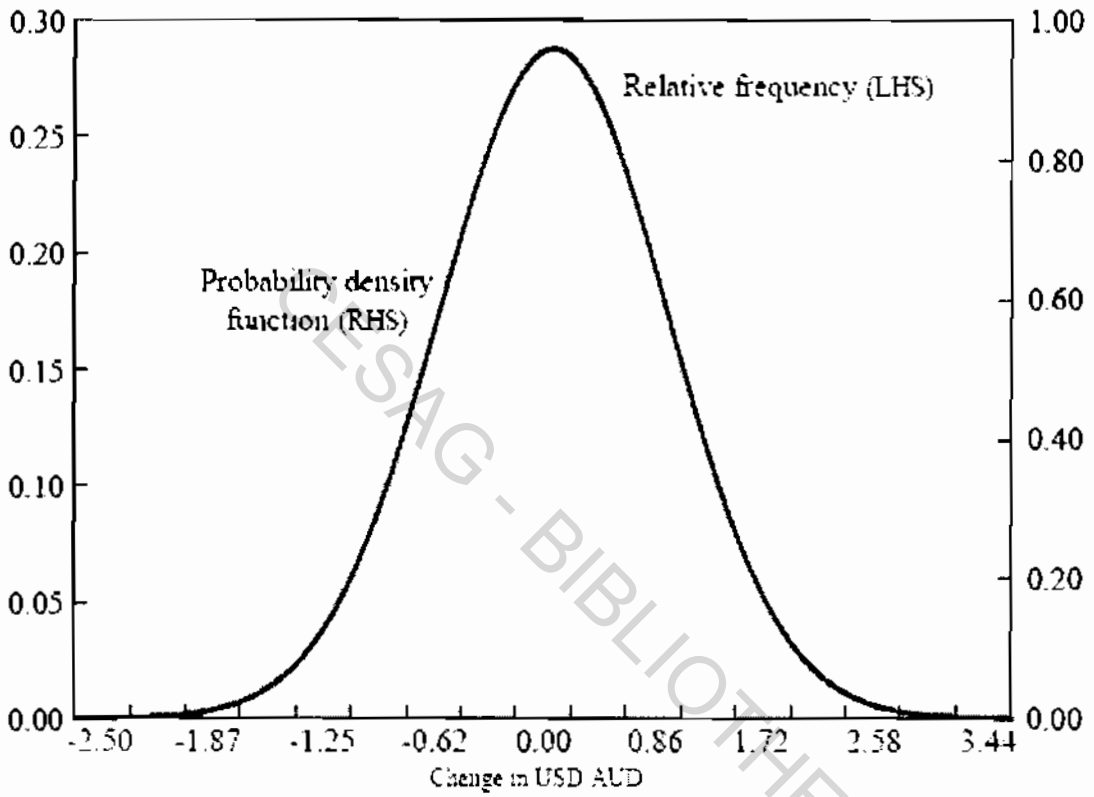


Chart 7: Distribution of daily returns in USD/AUD exchange rate



Source: Reserve Bank of Australia

Table 3 shows the revalued portfolio given the foreign exchange rates on 5 June 1996.

Table 2: Portfolio Value as at 5 June 1996

Positions	Spot FX rate	Position value	AUD equivalent
Position 1	JPY/AUD 86.46	100 000	JPY 1 156.60 (100000/86.46)
Position 2	USD/AUD 0.7943	-10 000	USD-12 589.70 (-10 000/0.7943

The introduction of the three methodologies in the banking sector worldwide has been progressive. Thus in Australia the parametric approach was the first, then the historical simulation comes before the Monte Carlo simulation.

II.1 Variance-covariance Approach

As discussed in the first part, Varianee-covariauce method is the simplest of VaR approaches in terms of computation. For this reason, it is often used by globally active banks which need to aggregate data from a large number of trading sites.

Variance-covariance VaR was the first of VaR approaches to be offered in off-the-shelf computer packages and hence, is also widely used by banks with comparatively low levels of trading activity.

Variance-eovariance approach is based on the assumption that financial-asset returns and hence, portfolio profits and losses are normally distributed. The consequenee of these two assumptions is that VaR can be expressed as a function of:

- Variance-covariance matrix for market-price returns; and
- the sensitivity of the portfolio to price shifts.

The first stage of Variance-eovariance approaeh requires the calculation of a Variance-covarianec matrix using the 250 days of historical data for the two series of daily exchange rate returns.

Variance-covariance matrix for this example is expressed as shown at the next page.

$$M = \begin{bmatrix} \sigma_{JPY}^{2} & \sigma_{JPY,USD} \\ \sigma_{JPY,USD} & \sigma_{USD}^{2} \end{bmatrix}$$

$$= \begin{bmatrix} 0.753 & 0.228 \\ 0.228 & 0.173 \end{bmatrix}$$

where σ_{JPY}^{2} is Variance of the series of daily returns for JPY/AUD, σ_{USD}^{2} is Variance of the series of daily returns for USD/AUD and σ JPY/ USD the covariance between the two series.

The second step in this approach is to calculate the market price sensitivities or deltas of the portfolio; that is, the amounts by which the portfolio value will change if each of the underlying market prices change by some pre-specified amount. To do this, movements in each of the market prices which affect the value of the portfolio are examined separately. Table 1 shows the change in the portfolio given a 1 per cent move in each of the spot FX rates.

Table 3: Methodology for Calculating the Delta of Each Position in the Portfolio

Current Revalued (assuming a 1% increase in AUD)

	FX rates	**Revalued**	
JPY/AUD	86.46	87.32	(1.01 x 86.46)
USD/AUD	0.7943	0,8022	(1.01 x 0.7943)
Portfolio value (AUD)			
Position 1	1 156.61	1 145.15	(100 000 / 87.32)
Position 2	-12 589.70	-12 465.05	(-10 000 / 0.8022)
Change in portfolio value or delta (AUD)			
Position 1	-11.45		
Position 2	124.65		

The third step in this approach is to calculate the standard deviation or volatility of total changes in portfolio value. Since total portfolio changes are assumed to be normally distributed, the volatility of portfolio changes can be expressed as a function of the deltas, the standard deviations of the two market-factor returns and the covariance between them. Let ***d*** be the vector of market-price sensitivities or deltas. If the standard deviation of portfolio changes is v and Variance covariance matrix of the market prices is **M** then v is expressed as:

$$v = \sqrt{\delta' M \delta}$$

In this example $\boldsymbol{v}$ is given by:

$$v = \sqrt{\begin{bmatrix} \delta_{JPY} & \delta_{USD} \end{bmatrix} \begin{bmatrix} \sigma_{JPY}^2 & \sigma_{JPY,USD} \\ \sigma_{JPY,USD} & \sigma_{USD}^2 \end{bmatrix} \begin{bmatrix} \delta_{JPY} \\ \delta_{USD} \end{bmatrix}}$$

$$= 46.22$$

The standard deviation of changes in the portfolio total value is 46 AUD. To establish VaR number of the portfolio for a given level of confidence the standard deviation must be multiplied by the relevant scaling factor, which is derived from the standard normal distribution. For example, if a 99 per cent level of confidence is desired the appropriate scaling factor is 2.33 since the probability of occurrence of a number less than -2.33 is 1 per cent. Scaling the standard deviation of the portfolio by this amount yields a VaR number which should only be exceeded by 1 per cent of the time.

Table 5 shows VaR amounts, given 95 and 99 per cent levels of confidence, for the example portfolio. It is clear that the higher the level of confidence, the larger VaR number will be: given Various assumptions there is a 5 per cent probability that the loss on the portfolio will exceed 76 AUD and only a 1 per cent probability that the loss on the portfolio will be larger than 108 AUD.

Table 4: Value-at-risk using Variance-covariance Approach

Confidence level	Scaling factor	Value-at-risk number
95 per cent	1.645	76.02 AUD (46.21x1.645)
99 per cent	2.330	107.67 AUD (46.21x2.33)

Variance-covariance approach is the simplest . However the Historical and Monte Carlo simulations are advanced tools. But their measures are more reliable. We will just present their methodologies.

II.2 The Historical-simulation Approach

The historical-simulation method is more computationally intensive than Variance-covariance approach and its use emerged within the Australian banking industry a little later. While only three banks have been using historical simulation for some time, the development of historical databases of market prices, together with more powerful (and less expensive) computer technology, has led several other banks to move towards the use of this approach.

The historical-simulation approach also uses historical data on daily returns to establish a VaR number, however, it makes no assumptions about the statistical distribution of these returns.

We do not enter into the details but we propose a methodology ;

Methodology

- Create a database with daily movements in market prices over a long period of time (several years)
- Consider n observations in this database, and make n simulations of the portfolio change for each period 1, 2, ……., n
- Calculate the percentiles of the portfolio change distribution and find the value of VaR at 0.01, 0.05 percentiles, etc

II.3 The Monte-Carlo Simulation

This method is not widely used by banks a part from very big hanks. Monte-Carlo techniques are extremely compnter intensive and the additional information that thesc teehniques provide is of most use for the analysis of complex options portfolios. To date, the use of the Monte-Carlo simulation has been limited principally to the most sophisticated hanks and securities houses operating in the US. The Monte-Carlo method is based on the generation, or simulation, of a large numher of possible future price changes that could affect the value of thc portfolio. The resulting changes in portfolio value are then analysed to reach a single VaR number.

Methodology

- Dctermine the market value of the portfolio at the end of the day
- Sample the price changes of portfolio components from a multivariate normal distrihution
- Use thcse sampled changes in market prices to dctermine the possible value of the portfolio
- Subtract the value of the market value from the possible value in order to determine the possible portfolio change
- Repeat this mcthodology for thousands times to huild up a probability distribution for the possible portfolio change.

The Monte-Carlo process allows analysis of the impact of events that wcre not in fact observed ovcr the historical period but are just as likely to occur as cvents that were observed. It is this capacity to evaluate likely cvents that have not occurred is onc of thc main attractions of this approach.

Each approach differs from the othcrs and has its strengths and weaknesses . The empirical performance of a VaR method depends on thc approach used, on the assumptions on probability distrihution, on the volatility valuation method, etc...

But VaR does not account for large movements in market prices, and for crises evcnts.

Hence it VaR must be completed with backtesting and stress testing for better results.

III COMPLEMENTS TO VaR

To perform VaR methodologies the Committee on the Global Financial System has required from banks to use back testing in conjunction with internal models approach to market risk used and the stress testing for extreme events. But these two techniques are important and can he developed as entire subject. In our case here we will just give some information on how to practise the techniques.

III.1 Backtesting

Above all the particularities of the methodologies, an advised way to see the performance of a methodology is to confront VaR estimated with the effective profit & loss realised in terms of percentages. This is called hacktesting . It answers the question how well VaR estimates would have performed in the past. Otherwise, it provides a useful diagnostic information for evaluating the model performance.

It consists in looking how often the daily losses exceed VaR measure. So if this is greater than 10% the methodology is suspicious. That is to say the choice of the methodology depends on the portfolio considered.

III.2 Stress testing

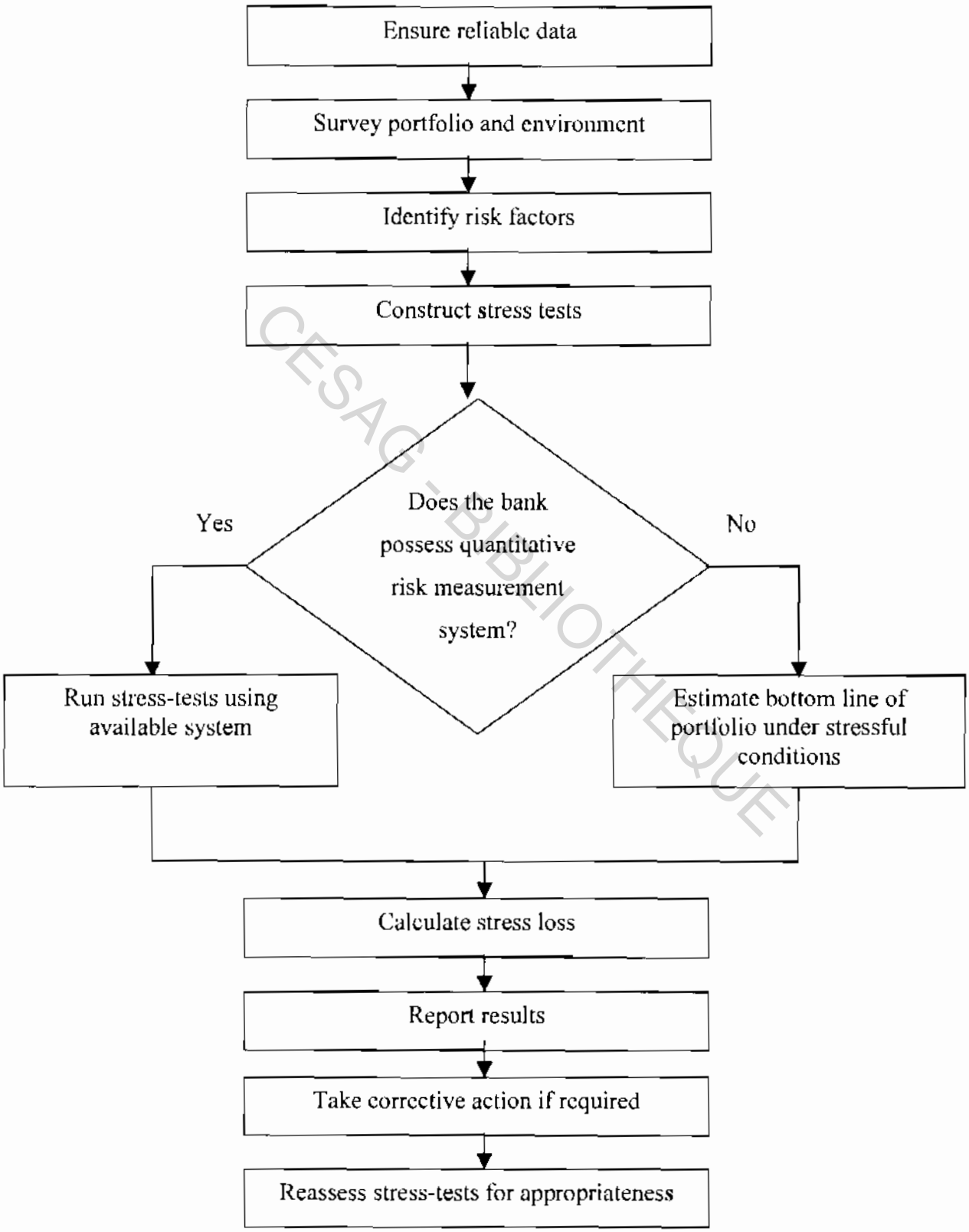
We have seen that VaR estimates market risks in normal market conditions, it is estimated using historical returns, that most often draws failures. One of the main solution to that is the use of stress tests. In fact for good performance, VaR should be completed by stress testing to take into account scenarios like crises. In fact stressful events have been occurring with alarming regularity and while there are no longer low probabilities their impact is still severe . In the last 10 years alone there have been about 10 stress events, some examples of which are the Gulf War, the Asian crisis and the Russian Default, one of the most recent of those crises was the terrorist attacks of September 11th . But what is stress testing?

The Basel Committee on the Global Financial System (BCGFS) (2000) defines stress testing as a generic term describing various techniques used by financial firms to gauge their potential vulnerability to exceptional but plausible events.

There is no standard stress testing so we are careful to avoid prescribing any off-the-shelf stress tests because stress-tests must be designed only after taking into account the idiosyncrasies of each portfolio. It is more important to master how to construct a stress test because scenarios are subjective thus it is difficult to construct reliable stress tests. It would be advisable to know a process to follow.

The chart at the next page describes a process for a stress testing programme settlement.

Chart 8: Flowchart for a stress testing programme building



Source: Risk management

All the methodology process of stress tests given above in programme is explained below by step following the programme guideline.

III.2.1 Ensure reliability of data

One of the most important step in stress testing is to ensure that the data being used in risk management is accurate and timely.

The bank should have access to accurate and timely market data about various factors such as interest rates, exchange rates …Those data are available once VaR is computed.

III.2.2 Survey

Identify risk factors influencing each financial instrument. Survey the social, industrial, economic and political environments to spot potential stressful events.

III.2.3 Type of risk factors

Some of the main risk factors that can be used are as follows: FX, interest, equity, commodity

III.2.4 Magnitude of factor shocks

Decide the magnitude of the shock that should be administrated to each risk factor. One approach is to use the magnitude of shocks that actually occurs during historical stress episodes, while another is to use subjective judgement .

III.2.5 Constructing stress tests

An example can be taken in past crises to construct a stress testing. See appendix n°2

III.2.6 Conducting stress tests

Use one of the models available to the bank to run the stress test. Or conduct a bottom line method to set up a stress test.

III.2.7 Reporting stress test results

A brief summary of results showing details of scenarios should be reported to appropriate managers for action.

III.2.8 Systematically reassessing appropriateness of stress test

Adapt stress tests to the changing environment by reviewing.

Stress testing is a technique used to complement VaR measures for extreme events. It allows the markets risk measures in general and exchange rates risk in particular to be more complete so as to have fuller picture of risk measure by taking into account all the possibilities but no only normal market conditions. To really perform VaR stress testing the process needs to be reviewed and well conducted.

But the construction and conduction of stress testing are most often very difficult. In fact, the use of stress tests is the assumption that the new distribution of returns, volatilities and correlations would be a repeat of what happened during some past crisis. It is a step forward not to view the future as an average of the past, but this will also be off the mark given the underlying process we have observed. If the markets we currently own were at the centre of the last crisis, the history of negative returns and high covarianecs would suggest. The stress test will significantly overestimates the risks. More worrying, if the markets you are in appeared safe during the last crisis, which is perhaps why we and everyone else are there, this concentration of positions will make the future distribution far riskier than during the last crisis. Repeating the past crisis on your portfolio is a distraction. What we need to focus on is how a reaction to the past will shape the future (Avinash Persaud, December 2002)[15].

[15] Avinash Persaud : The Folly of VaR . He is Gresham Professor of Commerce and Managing Director,Global Head of Rescach , state street

Chapter 3

IMPLEMENTATION OF THE PARAMETRIC APPROACH WITH A PORTFOLIO OF THE GHANA COMMERCIAL BANK

In this third part, which is related to the implementation of Variance-covariance approach of Value at Risk technique, we will first of all try to justify the assumptions of the approach before using it, in line with the requirements of the method.

We have chosen this methodology because it is easy to implement but mostly because of the nature of the asset we are dealing with. The methodology is very appropriate to linear assets like foreign exchange rates.

Ghana Commercial Bank Limited has many transactions in foreign currencies. The amount allocated to invest in foreign currencies increases each year. However the volatility of the local currency, the GHC is also important, and has a considerable impact on the business of the banking industry in general and the one of the bank(Ghana Commercial Bank) in particular. So it will be very useful to first of all have an idea of the amount that can be lost and in the limit of the possibility try to control it .

I VAR ESTIMATION

As we have mentioned in the earlier Value at Risk techniques and the parametric approach to compute the risk. To see the significance of our work we have taken the portfolio of two foreign currencies in which the bank has decided to invest the most, at the heginning of the year, January 2nd 2003.

The investments are made in US dollar and EUR. So the portfolio will be affected by movements in both USD/GHC and EUR/GHC exchange rates.

The following table shows the amounts.

Table 5: constitution of the portfolio

currency 1	50 000 000	EUR Long position
currency 2	32 400 000	USD Long position

We have two long positions in different currencies EUR and USD because the bank will have to receive the equivalent of these amounts at the investment term set.

As the determination of Value at Risk is based on the historical behaviour of the market prices that affect the value of the portfolio, we have taken into account the Basel Committee requirements. we have used 1000 days of historical data, from 04/01/1998 to 03/01/2003 to perform Value at Risk calculations because it is shown that the longer the period of the observations is the better the result will reflect the historical information.

The data and the methodology of calculation used are given on appendices 3 and 4 . We computed the daily returns and established the histograms in charts 9 and 10 for USD/GHC and EUR/GHC.

All the calculations and charts of this part have been done by us.

Our methodology adopted is as follows :

- have 1000 daily historical data for in each currency in terms of GHC
- calculate the daily returns
- determine the frequencies
- use the set confidence level
- and use the normal distribution on excel

Chart 9 :Distributiou of daily Returns in EUR/GHC Exchange Rate

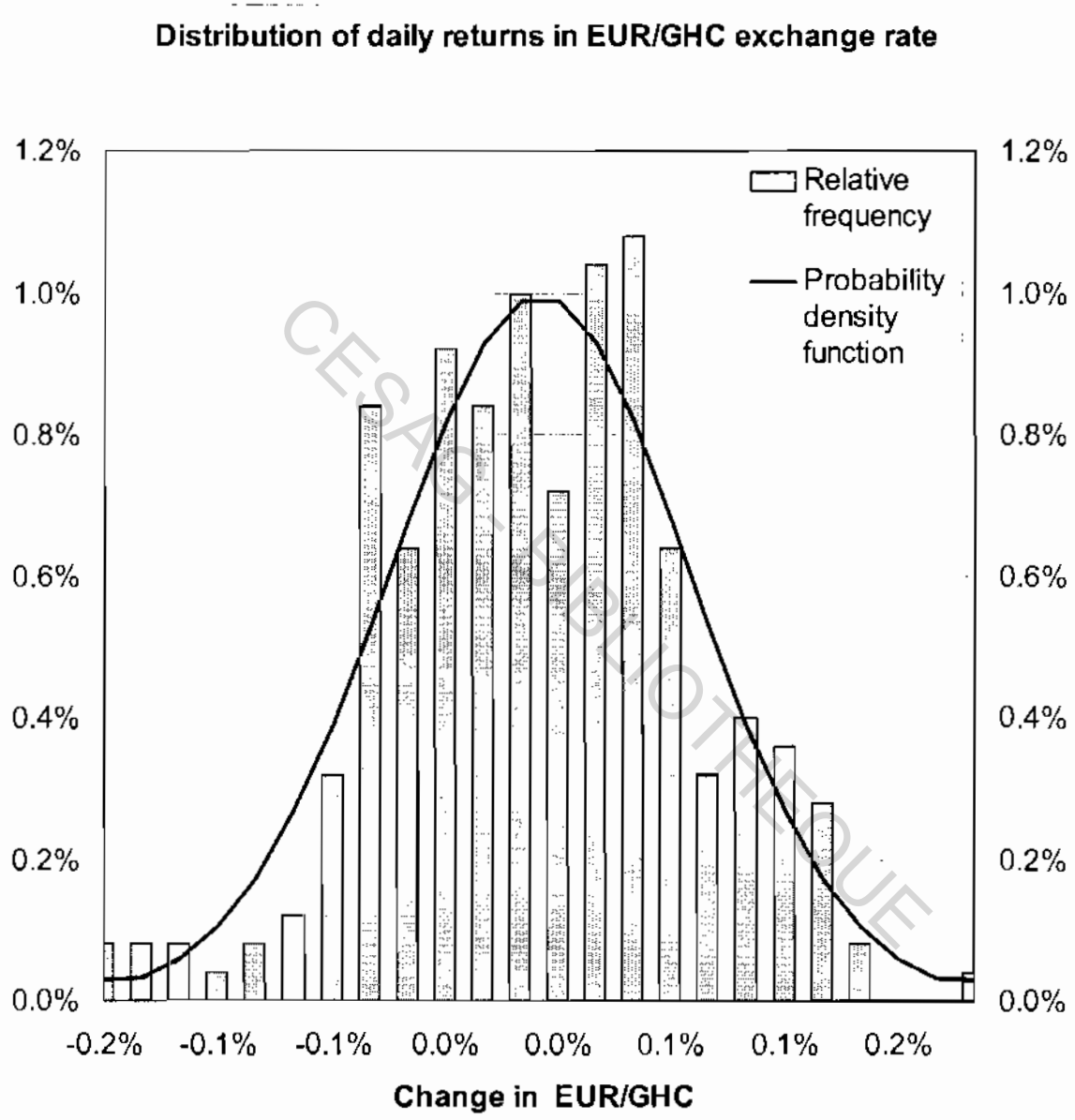
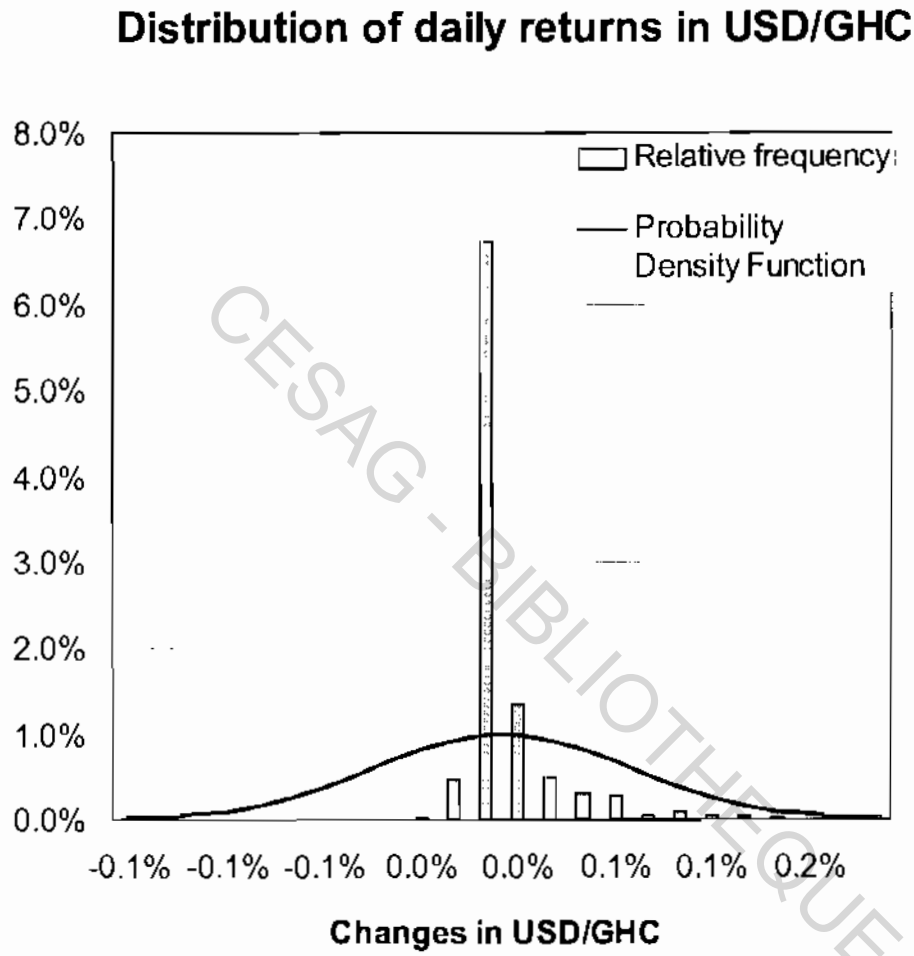


Chart 10: Distribution of daily returns in USD/GHC



The smooth line in each chart represents a normal distribution with the same mean and standard deviation as the data. In both upper and lower tails of each series, the actual frequency of returns are not totally similar to that expected if returns were normally distributed. Thus both series of daily returns appear more likely to be samples drawn from some distribution other than from a normal distribution .The implications of this result for the calculation of a VaR number is considered in the two assumptions admitted for the calculation of VaR.

Present value of the portfolio

Before starting the computation of VaR, whatever approach we use ,we need to revalue the portfolio at current market prices. The following table 10 shows the revalued portfolio given the foreign exchange rates on 03/01/2003.

Portfolio value as at 03/01/2003

Table 6: Revalued portfolio

Spot FX rate	value	GHC Equivalent
GHC/EUR 8603.77	50 000 000 EUR	430188500000 (50000000×8603.77)
GHC/USD 8351.91	32 400 000 USD	270601884000 (32400000×8351.91)

To obtain this table, we have used the value of the investment in each currency and we have converted these amounts into GHC using FX spot rate on the date of 03/01/2003. we have 8603.77 for EUR/GHC and 8351.91 for USD / GHC.

We use the parametric (Variance-covariance) method for our work for two reasons: firstly, because this approach is the simplest in terms of computation and secondly because it is easy to implement and cheaper as a tool.
With Variance-covariance approach VaR a is function of Variance-covariance matrix of market price returns and the sensitivity of the portfolio.

The first step of this widely used approach requires the evaluation of a Variance-covariance matrix using the 1000 days of historical data for the two series of daily exchange rates returns. Following the procedure, Variance-covariance matrix in our case is expressed as :

$$M=\begin{bmatrix} \sigma_{EUR}^{2} & \rho_{EUR\,USD} \\ \rho_{EUR\,USD} & \sigma_{USD}^{2} \end{bmatrix}$$

$$M=\begin{bmatrix} 0.000036513 & -0.000000409 \\ -0.000000409 & 0.00003483 \end{bmatrix}$$

Where σ_{USD}^{2} is Variance of the series of daily returns for USD/GHC, σ_{EUR}^{2} is Variance of the series of daily returns for EUR/GHC and $\rho_{EUR.USD}$ is the covariance between the two series.

The comments of the negative correlation is given below in the analysis of the results.

After the matrix, the second step in this approach is the evaluation of the portfolio market price sensitivities, that is the amounts by which the portfolio value will change if each of the underlying market prices changes by some pre-specified amount. To do this, we must examine separately movements by imagining hypothetical changes in the value of each of the market prices which affect the value of the portfolio.

The following table shows the change in the portfolio given a 1 percent move in each of the spot FX rates.

Table 7 : Calculation of the delta of each position in the portfolio

	Current	revalued (assuming a 1% increase in GHC)	
FX rates			
GHC/EUR	8603.77	8689.81	(1.01×8603.77)
GHC/USD	8351.91	8435.43	(1.01×8351.91)
Portfolio value (GHC)			
Position 1(EUR)	430 188 500 000	434 490 500 000	
Position 2(USD)	270 601 884 000	273 307 932 000	
Change in portfolio value or delta (GHC)			
GHC/EUR	4 302 000 000		
GHC/USD	2 706 048 000		

One of the important points of this approach is the calculation of the standard deviation and the volatility of total changes in portfolio value . As mentioned in the second part ,the total portfolio changes can be expressed as a function of the deltas, the standard deviations of the two market price sensitivities or deltas.

The computation of standard deviation is given by :

$$V=\sqrt{(4302000000;2706048000)\begin{bmatrix}0.00003613 & -0.000000409\\ -0.000000409 & 0.00003483\end{bmatrix}\begin{pmatrix}4302000000\\2707048000\end{pmatrix}}$$

V=30 235 609.08

At this level we can establish Value at Risk number of the portfolio by multiplying the standard deviation by the relevant scaling factor (1.645), which is derived from the standard normal distribution.

We are using a 95 per cent of level of confidence with the corresponding scaling factor of 1.645. The choice of this level of confidence and the related scaling factor is in line with the Basel Committee on the market risk requirements.

The Value-at-Risk number is finally given in the table below:

Table 8: Value at Risk with Variance covariance approach

Value-at-Risk using Variance-covariance approach (in GHC)		
Confidence level	95 per cent	
Scaling factor	1.645	
Value-at-Risk daily number	49737576.94	(30235609.08×1.645)
Value-at-Risk monthly number	227926211.2	$(49737576.94\times\sqrt{21})$
Value-at-Risk number for the year	789559556.4	$(49737576.94\times\sqrt{252})$

II VALUE AT RISK RESULTS ANALYSIS AND BACKTESTING

Before analysing the results, we would like to comment the negative correlation between the two currencies used: EUR and USD.

$\rho_{EUR\,USD} = -0.000000409$ We can infer that the two curreneies are not correlated. In fact the two currencies do not depend on the same faetors. While the USD depends mostly on oil market, the EUR does not . Also they reflect eeonomies of two different zones.

In the case of a portfolio in general and ours in particular, we can say that the two instruments do not vary in the same way. So if one of them is very risky the other one could be less risky, thus the impact will not be very important on the considered portfolio. And in the case that one of them is highly risky, for a risk management purpose, the riskiest instrument could be withdrawn from the portfolio without negative effect on the portfolio.

II.1 VaR results analysis

The daily Value at Risk (VaR) number is GHC 49340465.63 .That means in 95% of the cases the investment will lose at most GHC 49340465.63 on a daily basis. Otherwise the worst of the cases that could occur can not be more than this amount from 1-day to another.

So with the risk of 5% and a horizon of one day, the amount of VaR means that there is a probability of 95% of chances that the potential loss on the analysed portfolio value be less than GHC 49340465.65. And inversely there is 5% of chanees that the loss be more than that value estimated that seemed to be a level of risk a bit probable but not without importance (5% is equivalent to 1 observation out of 20) to be appreciated and managed .

In reasoning in a similar way for respectively the monthly and the annual VaR numbers, we can easily say that in 95% of the cases the amount invested can not exceed GHC 227926211.2 on a monthly basis and 789559556.4 on annual basis.

Let's see the percentages of the different VaR measures in terms of the portfolio present value.

The total value of the portfolio as at 03/01/2003 is 700790384000 GHC.

So we have the following table.

Table 9 VaR in terms of the portfolio value

Percentage of VaR in terms of the portfolio value	
1 day	0.0007%
1 month	0.0325%
1 year	0.1127%

The potential loss is less than 10% of the portfolio value when the holding period is less than 1 year. When the holding period is long (1 year or more) the potential loss represents an important proportion of the portfolio value. The use of backtesting will give more precision for an inference.

II.2 Backtesting

The need of doing a backtesting is important for a diagnosis of the methodology to our portfolio, but we only got the effective loss of the portfolio for the end of the month of January. The other values would be available by the end of year 2003.

At the end of January the portfolio value is GHC 700 567 016 313.02. So the effective loss is GHC 223 367 686.98. This amount exceeds the monthly VaR value by 9.80%. We can thus conclude that the parametric approach is appropriate to the portfolio for a holding period up to one month .

For the one-year holding period we can't conclude but we know that the effective loss must not exceed the GHC 78 955 955,64 which is 10% of the one-year VaR value.

III PROPOSALS

In this section, some proposals relating to the use of Value at Risk are made. Firstly we deal with the case of industrialised countries that are already using it but in diversified ways. Then the case of emerging countries. This distinction is made owing to the economic situation of each block. In fact, according to professor Avinash Persaud, the evolution of the crises situation in the two blocks is different. After a study, he pointed out that across a broad seep of time, the number of currency crises appears to rise. Eichengreen and Bordo have calculated the number of occasions that currencies have come under intense pressure in developed and developing countries during the last century – see appendix 5 .[16]

The crises are more intense in developing countries than in the developed ones. And we now know that for a good performance of Value at Risk a completion with stress tests is necessary.

[16] See Barry Eichengreen and Micheal Bordo, Crises Now and Then : What lessons from the last era of financial globalisation , Jannary 2000

VaR must used for market risks measurement and also for credit risk measurement.

Here, we share the point of professor Avinash Persaud in his proposal for dealing with stress testing. According to him, we will have to consider that covariances between assets in a crisis are made up of two elements : the long-run structural covariance between the two assets and a cyclical component . The structural element can be estimated by looking at the covariances of economic data such as current-account positions between countries or companies. This covariance of the fundamentals represents a minimum for the overall degree of covariance of market prices.

Then, the cyclical component is added to the structural covariance. The determination of this cyclical component could be done using past covariances but precisely using the opposite way of how it is done today.

Instead of assuming that the future is some positive function of the past, let us assume it is an inverse reaction to the past, in that low covariances in the past mean high covariances today and vice versa. This approach would be time-consistent with a variety of assumptions on investors' behaviour.

Concerning the developed countries where VaR is actively used as the most convenient for market risk measurement, all the three methods are used depending on the component of portfolios. A backtesting will therefore be very necessary to accommodate a method. Then it is completed with stress tests taking into account their frequency of occurrence after a good study.

In developing countries, banks as well as exporting and importing companies are exposed to market risks.

The parametric VaR seems to be available to developing countries for two reasons . Firstly it is the simplest of the three methodologies in terms of estimation and implementation, no need for a very performing technology. And we think that for a beginning, it is good. All the leading banks in the world including those of Australia, a case already discussed, have started with this approach. A simple pricer can help have good compuration to get relevant results.

The second reason is that this method deals with linear underlined assets. And we know that developing countries do not deal with so sophisticated instruments like options and derivatives yet.

Besides, it is crucial to note that whatever methodology used must be completed with backtesting to see its convenience and stress testing. As we have mentioned above, in developing countries crises seem to occur very often, so good stress tests must be based on regularity of crises.

GENERAL CONCLUSION

The introduction of VaR has been an important step in the direction of coherent and adequate measure of market risk. Its use has spread remarkably rapidly across the financial industry since the mid 90s . As the techniques have become more widespread, the range of methods for calculating VaR estimates has broadened. Recommended by the Basel committee for capital requirement, it is very useful to have a control of market risk in general and exchange rate risk in particular.

This work has allowed us to clarify VaR technique through its origin, the definition of the term and most importantly the illustration of its methodologies. We have shown that there are some advantages and inconveniences to measure market risk using one methodology or another.

So a good use of VaR needs an in-depth understanding of the tool and its limits. One of the limits is that VaR is determined under normal market conditions. It does not take into account extreme cases like crises. So the Basel committee has required to complete VaR measures by backtesting and stress testing.

VaR has been widely used for banks trading portfolio and for risk management purposes. Using VaR, a bank can monitor the business risks that arise from a wide range of sources, including exchange rate risk .In the risk management process VaR is used for: risk reporting, resources allocation and investments, risk limits and regulatory capital requirements .

We have illustrated VaR with spot foreign exchange portfolio because it is a linear asset that made our computations easy .

The case of Ghana commercial bank was our creative part in this interesting study to recommend the use of VaR in the risk management process. In fact all the banks are exposed to markets risks depending on the importance of their activities. This example has been

chosen for the purpose encouraging banks to opt for the use of VaR as their internal risk measurement tool. For banks in the developed countries where VaR is common language, its results must be improved as mentioned above and for developing and emerging countries a familiarisation with the tool is unavoidable to improve their business results. All the methodologies outlined here can be applied to any arbitrary market risk portfolio.

Now, VaR is even recommended by the Basel committee for application to the credit risk management.

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APPENDICES

- Appendix 1 : EMBI+, S&P 500
- Appendix 2 : Presentation of some recent crises
- Appendix 3 :Observations of daily returns Of USD/GHC
- Appendix 4 :Frequencies calculation
- Appendix 5: Chart of crises comparison in developing and developed countries

APPENDIX 1

Notions on EMBI+

EMBI+ : The Emerging Markets Bond Index Plus (EMBI +) , tracks total returns for traded external debt instruments in the emerging markets. The instruments include external-currency-denominated Brady bonds, loans and Eurobonds, as well as U.S dollar local markets instruments. The EMBI+ expands upon Morgan's original Emerging Markets bond Index , which was introduced in 1992 and covers only Brady bonds.

In addition to serving as benchmark, the EMBI+ provides investors with a definition of the market for emerging markets external-currency debt, a list of the instruments traded, and a compilation of their terms.

The EMBI+ is concentrated in instruments from three mayor Latin America countries (Argentina, Brazil and Mexico) and some non-Latin countries (Bulgaria, Morocco, Nigeria, the Philippines, Poland, Russia and South Africa).

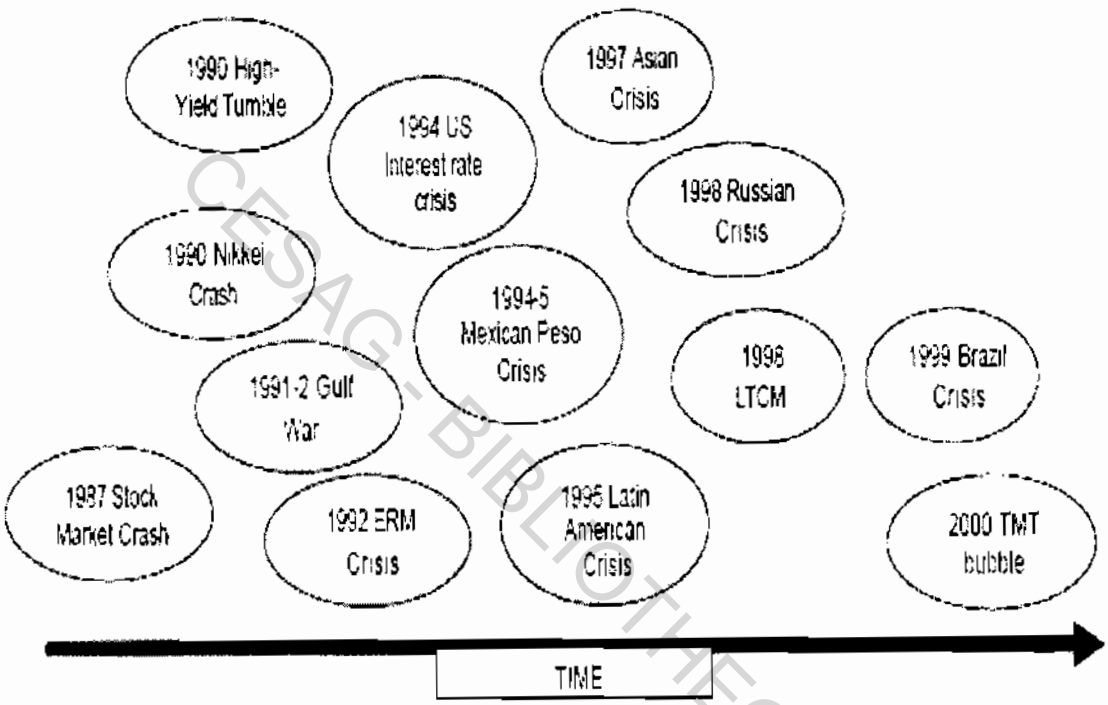
Instruments in the EMBI+ must have a minimum of $ 500 million outstanding.

Notions on S&P 500 Index

S&P 500 stands for Standard & Poor's 500 .A baskets of 500 stocks that are considered to be widely held. The S&P 500 Index is weighted by market value and its performance is thought to be representative of the stock market as a whole . It has been created in 1957.

APPENDIX 2

Example of some of the recent financial market crises



Source: Consultative paper from Market infrastructure and Risk Advisory Department Monetary Authority of Singapore

APPENDIX 3 : Daily observations and equivalent returns of USD/GHC from 04/01/1999 to 31/12/2002

DATES	USD/GHC	Returns
04/01/1999	2 346.46	
05/01/1999	2 346.91	0.0192%
06/01/1999	2 347 55	0 0273%
07/01/1999	2 347.64	0.0038%
08/01/1999	2 347.64	0 0000%
11/01/1999	2 349.46	0.0775%
12/01/1999	2 350.87	0.0600%
13/01/1999	2 351.82	0.0404%
14/01/1999	2 351.86	0.0017%
15/01/1999	2 356.09	0.1797%
16/01/1999	2 353.37	-0.1155%
17/01/1999	2 353.46	0.0038%
18/01/1999	2 353.73	0.0115%
19/01/1999	2 354.50	0.0327%
20/01/1999	2 354.59	0.0038%
21/01/1999	2 355.50	0 0386%
22/01/1999	2 355.59	0.0038%
23/01/1999	2 356.50	0.0386%
24/01/1999	2 356.82	0.0136%
01/02/1999	2 358.00	0.0501%
02/02/1999	2 358.00	0 0000%
03/02/1999	2 358.46	0.0195%
04/02/1999	2 358.73	0.0114%
05/02/1999	2 359.18	0.0191%
08/02/1999	2 359.45	0.0114%
09/02/1999	2 361.50	0.0868%
10/02/1999	2 361 73	0.0097%
11/02/1999	2 362.46	0.0309%
12/02/1999	2 363.28	0.0347%
15/02/1999	2 364.32	0.0440%
16/02/1999	2 365.77	0.0613%
17/02/1999	2 366.37	0 0254%
18/02/1999	2 366.55	0.0076%
19/02/1999	2 367.46	0.0384%
22/02/1999	2 367.55	0.0038%
23/02/1999	2 368 27	0.0304%
24/02/1999	2 368.27	0.0000%
25/02/1999	2 368.64	0.0156%
26/02/1999	2 369.68	0.0439%
01/03/1999	2 370 50	0.0346%
02/03/1999	2 371.18	0.0287%
03/03/1999	2 374.00	0 1189%
04/03/1999	2 375.50	0.0632%
05/03/1999	2 376.55	0 0442%
08/03/1999	2 378.14	0.0669%
09/03/1999	2 379.37	0 0517%

10/03/1999	2 379.68	0.0130%
11/03/1999	2 381.73	0 0861%
12/03/1999	2 385.78	0.1699%
15/03/1999	2 389.46	0.1541%
16/03/1999	2 395.64	0.2583%
17/03/1999	2 397.59	0.0814%
18/03/1999	2 403.09	0.2291%
19/03/1999	2 406.00	0.1210%
22/03/1999	2 406.46	0.0191%
23/03/1999	2 411.09	0.1922%
24/03/1999	2 413.09	0.0829%
25/03/1999	2 413.73	0.0265%
26/03/1999	2 414.23	0.0207%
29/03/1999	2 415 18	0 0393%
30/03/1999	2 415.73	0.0228%
31/03/1999	2 416.05	0.0132%
01/04/1999	2 418.55	0.1034%
06/04/1999	2 418.77	0.0091%
07/04/1999	2 419.68	0.0376%
08/04/1999	2 420 28	0.0248%
09/04/1999	2 421.05	0.0318%
12/04/1999	2 421.14	0.0037%
13/04/1999	2 422.50	0 0562%
14/04/1999	2 422.10	-0.0165%
15/04/1999	2 423.00	0.0372%
16/04/1999	2 425.96	0.1221%
19/04/1999	2 427.86	0.0783%
20/04/1999	2 430.27	0.0992%
21/04/1999	2 433.46	0.1312%
22/04/1999	2 436.05	0.1064%
23/04/1999	2 437.28	0.0505%
26/04/1999	2 436.50	-0.0320%
27/04/1999	2 436.59	0.0037%
28/04/1999	2 436.73	0.0057%
29/04/1999	2 438.82	0.0857%
30/04/1999	2 440 27	0.0594%
03/05/1999	2 440.78	0.0209%
04/05/1999	2 440 86	0.0033%
05/05/1999	2 441.78	0.0377%
06/05/1999	2 444 27	0 1019%
07/05/1999	2 444.73	0.0188%
10/05/1999	2 445.28	0.0225%
11/05/1999	2 445.32	0.0016%
12/05/1999	2 447.59	0.0928%
13/05/1999	2 448.19	0.0245%
14/05/1999	2 448.50	0.0127%
17/05/1999	2 450 77	0.0927%
18/05/1999	2 452 23	0.0596%
19/05/1999	2 454 91	0.1092%
20/05/1999	2 455 32	0.0167%
21/05/1999	2 455.87	0.0224%

24/05/1999	2 455.91	0.0016%
25/05/1999	2 458.41	0.1017%
26/05/1999	2 462.27	0.1569%
27/05/1999	2 463.87	0.0650%
28/05/1999	2 475.18	0.4580%
31/05/1999	2 481.27	0.2457%
01/06/1999	2 481.68	0.0165%
02/06/1999	2 486 05	0.1759%
03/06/1999	2 490.50	0.1788%
07/06/1999	2 495.00	0.1805%
08/06/1999	2 496.41	0.0565%
09/06/1999	2 500.41	0.1601%
10/06/1999	2 503.73	0.1327%
11/06/1999	2 503.41	-0.0128%
14/06/1999	2 504.32	0.0363%
15/06/1999	2 505 00	0.0271%
16/06/1999	2 504 87	-0.0052%
17/06/1999	2 506.23	0.0543%
18/06/1999	2 507.96	0 0690%
21/06/1999	2 508.46	0.0199%
22/06/1999	2 510.32	0.0741%
23/06/1999	2 515.19	0.1938%
24/06/1999	2 518 60	0.1355%
25/06/1999	2 522.09	0.1385%
28/06/1999	2 522 96	0.0345%
29/06/1999	2 527 37	0 1746%
30/06/1999	2 529.64	0.0898%
02/07/1999	2 532.14	0.0988%
05/07/1999	2 534.86	0.1074%
06/07/1999	2 537.14	0.0899%
07/07/1999	2 537.41	0.0106%
08/07/1999	2 537.82	0.0162%
09/07/1999	2 541.05	0.1272%
12/07/1999	2 543.82	0.1090%
13/07/1999	2 549.50	0.2230%
14/07/1999	2 552.27	0.1086%
15/07/1999	2 552.82	0.0215%
16/07/1999	2 555.41	0.1014%
19/07/1999	2 556 73	0 0516%
20/07/1999	2 559.55	0.1102%
21/07/1999	2 563 55	0.1562%
22/07/1999	2 565.37	0.0710%
23/07/1999	2 567 59	0.0865%
26/07/1999	2 568.32	0.0284%
27/07/1999	2 569.32	0.0389%
28/07/1999	2 569.32	0.0000%
29/07/1999	2 570.73	0 0549%
30/07/1999	2 570.63	-0.0039%
02/08/1999	2 570.87	0 0093%
03/08/1999	2 573.19	0.0902%
04/08/1999	2 574.14	0 0369%

05/08/1999	2 575.55	0.0548%
06/08/1999	2 575.78	0.0089%
09/08/1999	2 579.46	0.1428%
10/08/1999	2 580.68	0.0473%
11/08/1999	2 582.14	0.0566%
12/08/1999	2 582.68	0.0209%
13/08/1999	2 585.46	0.1076%
16/08/1999	2 587.91	0.0947%
17/08/1999	2 588.73	0.0317%
18/08/1999	2 588.77	0.0015%
19/08/1999	2 590.59	0.0703%
20/08/1999	2 592.82	0.0860%
23/08/1999	2 593.46	0.0247%
24/08/1999	2 594.46	0.0386%
25/08/1999	2 596.82	0.0909%
26/08/1999	2 597.23	0.0158%
27/08/1999	2 597.91	0.0262%
30/08/1999	2 598.28	0.0142%
31/08/1999	2 598.87	0.0227%
01/09/1999	2 599.05	0.0069%
02/09/1999	2 601.78	0.1050%
03/09/1999	2 604.09	0.0887%
06/09/1999	2 608.64	0.1746%
07/09/1999	2 609.46	0.0314%
08/09/1999	2 616.73	0.2782%
09/09/1999	2 624.41	0.2931%
10/09/1999	2 628.37	0.1508%
13/09/1999	2 630.64	0.0863%
14/09/1999	2 632.87	0.0847%
15/09/1999	2 636.69	0.1450%
16/09/1999	2 638.50	0.0686%
17/09/1999	2 640.18	0.0637%
20/09/1999	2 640.50	0.0121%
21/09/1999	2 641.00	0.0189%
22/09/1999	2 642.00	0.0379%
23/09/1999	2 643.55	0.0587%
24/09/1999	2 655.37	0.4461%
27/09/1999	2 662.05	0.2512%
28/09/1999	2 661.05	-0.0376%
29/09/1999	2 662.46	0.0530%
30/09/1999	2 670.00	0.2828%
01/10/1999	2 670.46	0.0172%
02/10/1999	2 671.69	0.0460%
05/10/1999	2 680.55	0.3311%
06/10/1999	2 687.64	0.2641%
07/10/1999	2 703.23	0.5784%
08/10/1999	2 720.37	0.6321%
11/10/1999	2 734.41	0.5148%
12/10/1999	2 745.14	0.3916%
13/10/1999	2 756.64	0.4180%
14/10/1999	2 776.46	0.7164%

15/10/1999	2 792.55	0.5778%
18/10/1999	2 807.28	0.5261%
19/10/1999	2 821.82	0.5166%
20/10/1999	2 833.05	0.3972%
21/10/1999	2 836.23	0.1122%
22/10/1999	2 843.41	0.2528%
25/10/1999	2 860.64	0.6041%
26/10/1999	2 874.46	0.4819%
27/10/1999	2 895.73	0.7372%
28/10/1999	2 928.91	1.1393%
29/10/1999	2 951.78	0.7778%
01/11/1999	2 990.32	1.2972%
02/11/1999	3 024.73	1.1441%
03/11/1999	3 054.00	0.9630%
04/11/1999	3 083.05	0.9467%
05/11/1999	3 096.64	0.4398%
08/11/1999	3 109.99	0.4302%
09/11/1999	3 140.82	0.9864%
10/11/1999	3 158.73	0.5686%
11/11/1999	3 215.78	1.7900%
12/11/1999	3 247.36	0.9772%
15/11/1999	3 256.73	0.2881%
16/11/1999	3 266.87	0.3109%
17/11/1999	3 288.96	0.6739%
18/11/1999	3 318.19	0.8848%
19/11/1999	3 319.27	0.0325%
22/11/1999	3 338.19	0.5684%
23/11/1999	3 347.73	0.2854%
24/11/1999	3 366.18	0.5496%
25/11/1999	3 390.28	0.7134%
26/11/1999	3 403.64	0.3933%
29/11/1999	3 308.45	-2.8366%
30/11/1999	3 317.91	0.2855%
01/12/1999	3 421.05	3.0612%
02/12/1999	3 427.73	0.1951%
06/12/1999	3 428.96	0.0359%
07/12/1999	3 437.86	0.2592%
08/12/1999	3 438.41	0.0160%
09/12/1999	3 446.27	0.2283%
10/12/1999	3 452.23	0.1728%
13/12/1999	3 455.82	0.1039%
14/12/1999	3 472.41	0.4789%
15/12/1999	3 475.78	0.0970%
16/12/1999	3 477.46	0.0483%
17/12/1999	3 477.82	0.0104%
20/12/1999	3 481.00	0.0914%
21/12/1999	3 482.82	0.0523%
22/12/1999	3 485.23	0.0692%
23/12/1999	3 487.82	0.0743%
24/12/1999	3 488.09	0.0077%
28/12/1999	3 495.73	0.2188%

29/12/1999	3 498.82	0.0884%
30/12/1999	3 500.69	0.0534%
03/01/2000	3 505.00	0 1230%
04/01/2000	3 507.05	0.0585%
05/01/2000	3 508.00	0.0271%
06/01/2000	3 512.05	0.1154%
07/01/2000	3 515.50	0.0982%
11/01/2000	3 516 09	0.0168%
12/01/2000	3 525.68	0.2724%
13/01/2000	3 536 68	0 3115%
14/01/2000	3 539.91	0.0913%
17/01/2000	3 550.18	0.2897%
18/01/2000	3 560.68	0.2953%
19/01/2000	3 563.55	0.0806%
20/01/2000	3 566.35	0.0785%
21/01/2000	3 567.55	0.0336%
24/01/2000	3 570.82	0.0916%
25/01/2000	3 573.32	0.0700%
26/01/2000	3 579 14	0.1627%
27/01/2000	3 585.78	0.1853%
28/01/2000	3 587.73	0.0544%
31/01/2000	3 587.73	0.0000%
01/02/2000	3 603.77	0.4461%
02/02/2000	3 608.73	0.1375%
03/02/2000	3 610 09	0.0377%
04/02/2000	3 617.77	0.2125%
07/02/2000	3 623.68	0.1632%
08/02/2000	3 627.64	0.1092%
09/02/2000	3 631.64	0.1102%
10/02/2000	3 640 23	0.2363%
11/02/2000	3 641.91	0.0461%
14/02/2000	3 644.68	0.0760%
15/02/2000	3 651.55	0.1883%
16/02/2000	3 672 41	0.5696%
17/02/2000	3 677.50	0.1385%
18/02/2000	3 682.73	0.1421%
21/02/2000	3 683.87	0.0310%
22/02/2000	3 686 73	0.0776%
23/02/2000	3 708 82	0.5974%
24/02/2000	3 727.41	0.5000%
25/02/2000	3 741.00	0 3639%
28/02/2000	3 746 05	0.1349%
29/02/2000	3 773.18	0.7216%
01/03/2000	3 780.18	0.1853%
02/03/2000	3 799.91	0.5206%
03/03/2000	3 817 73	0.4679%
07/03/2000	3 830.69	0.3389%
08/03/2000	3 838.27	0.1977%
09/03/2000	3 847.55	0.2415%
10/03/2000	3 854.32	0.1758%
13/03/2000	3 868.59	0.3696%

14/03/2000	3 891.00	0.5776%
15/03/2000	3 908.96	0.4605%
17/03/2000	3 932.64	0.6040%
20/03/2000	3 959.18	0.6726%
21/03/2000	3 984.00	0.6249%
22/03/2000	4 017.37	0.8341%
23/03/2000	4 030.55	0.3275%
24/03/2000	4 049.14	0.4602%
28/03/2000	4 052.18	0.0750%
29/03/2000	4 057.00	0.1189%
30/03/2000	4 080.64	0.5810%
31/03/2000	4 094.59	0.3413%
03/04/2000	4 122.23	0.6728%
04/04/2000	4 143.86	0.5233%
05/04/2000	4 165.73	0.5264%
06/04/2000	4 182.73	0.4073%
07/04/2000	4 188.86	0.1464%
10/04/2000	4 204.87	0.3815%
11/04/2000	4 243.23	0.9081%
12/04/2000	4 246.73	0.0825%
13/04/2000	4 285.14	0.9004%
14/04/2000	4 311.37	0.6102%
17/04/2000	4 318.78	0.1717%
18/04/2000	4 334.00	0.3518%
19/04/2000	4 344.73	0.2473%
20/04/2000	4 354.96	0.2352%
25/04/2000	4 354.55	-0.0094%
26/04/2000	4 387.68	0.7579%
27/04/2000	4 396.37	0.1979%
28/04/2000	4 422.87	0.6010%
02/05/2000	4 430.05	0.1622%
03/05/2000	4 449.09	0.4289%
04/05/2000	4 453.32	0.0950%
05/05/2000	4 458.23	0.1102%
08/05/2000	4 467.55	0.2088%
09/05/2000	4 465.23	-0.0519%
10/05/2000	4 481.82	0.3708%
11/05/2000	4 505.46	0.5261%
12/05/2000	4 505.46	0.0000%
15/05/2000	4 520.96	0.3434%
16/05/2000	4 527.82	0.1516%
17/05/2000	4 541.64	0.3048%
18/05/2000	4 568.32	0.5857%
19/05/2000	4 573.50	0.1133%
22/05/2000	4 587.37	0.3028%
23/05/2000	4 607.73	0.4428%
24/05/2000	4 657.32	1.0705%
25/05/2000	4 663.27	0.1277%
26/05/2000	4 696.05	0.7005%
29/05/2000	4 708.14	0.2571%
30/05/2000	4 727.55	0.4114%

31/05/2000	4 742.55	0.3168%
01/06/2000	4 758.87	0.3435%
02/06/2000	4 766.73	0.1650%
05/06/2000	4 774.68	0.1666%
06/06/2000	4 790.41	0.3289%
07/06/2000	4 805.50	0.3145%
08/06/2000	4 850.05	0.9228%
09/06/2000	4 884.23	0.7023%
12/06/2000	4 909.46	0.5152%
13/06/2000	4 923.41	0.2837%
14/06/2000	4 936.23	0.2601%
15/06/2000	4 947.87	0.2355%
16/06/2000	4 960.05	0.2459%
19/06/2000	4 979.32	0.3878%
20/06/2000	5 001.78	0.4501%
21/06/2000	5 057.91	1.1160%
22/06/2000	5 068.91	0.2172%
23/06/2000	5 100.37	0.6187%
26/06/2000	5 118.09	0.3468%
27/06/2000	5 188.09	1.3584%
28/06/2000	5 324.82	2.6013%
29/06/2000	5 411.37	1.6123%
30/06/2000	5 485.59	1.3622%
03/07/2000	5 499.14	0.2467%
04/07/2000	5 532.19	0.5992%
05/07/2000	5 564.77	0.5872%
06/07/2000	5 631.77	1.1968%
07/07/2000	5 652.41	0.3658%
10/07/2000	5 673.87	0.3789%
11/07/2000	5 744.00	1.2284%
12/07/2000	5 784.00	0.6940%
13/07/2000	5 839.91	0.9620%
14/07/2000	5 862.27	0.3822%
17/07/2000	5 883.83	0.3671%
18/07/2000	5 908.55	0.4193%
19/07/2000	5 936.68	0.4750%
20/07/2000	5 952.86	0.2722%
21/07/2000	5 972.50	0.3294%
24/07/2000	5 984.32	0.1977%
25/07/2000	6 024.50	0.6692%
26/07/2000	6 053.36	0.4779%
27/07/2000	6 049.59	-0.0623%
28/07/2000	6 062.32	0.2102%
31/07/2000	6 069.55	0.1192%
01/08/2000	6 088.37	0.3096%
02/08/2000	6 131.00	0.6977%
03/08/2000	6 170.55	0.6430%
04/08/2000	6 188.27	0.2868%
07/08/2000	6 187.55	-0.0116%
08/08/2000	6 217.10	0.4764%
09/08/2000	6 216.59	-0.0082%

10/08/2000	6 256.96	0.6473%
11/08/2000	6 277.87	0.3336%
14/08/2000	6 222.80	-0 8811%
15/08/2000	6 315.50	1.4787%
16/08/2000	6 332.09	0.2623%
17/08/2000	6 343.59	0.1814%
18/08/2000	6 345.32	0.0273%
21/08/2000	6 351.82	0.1024%
22/08/2000	6 354.68	0.0450%
23/08/2000	6 362.91	0.1294%
24/08/2000	6 374.09	0.1756%
25/08/2000	6 376.96	0.0450%
28/08/2000	6 384.50	0.1182%
29/08/2000	6 385.18	0.0107%
30/08/2000	6 397.50	0.1928%
31/08/2000	6 389 55	-0.1243%
01/09/2000	6 387.46	-0.0327%
04/09/2000	6 386.82	-0 0100%
05/09/2000	6 394.00	0.1124%
06/09/2000	6 404.91	0.1705%
07/09/2000	6 407.05	0.0334%
08/09/2000	6 418.60	0.1801%
11/09/2000	6 421.96	0.0523%
12/09/2000	6 440.37	0.2863%
13/09/2000	6 449 37	0.1396%
14/09/2000	6 454.28	0.0761%
15/09/2000	6 463 82	0 1477%
18/09/2000	6 469.23	0.0837%
19/09/2000	6 467.87	-0 0210%
20/09/2000	6 472.32	0.0688%
21/09/2000	6 495.46	0.3569%
22/09/2000	6 503.91	0.1300%
25/09/2000	6 506.95	0.0467%
26/09/2000	6 525.35	0.2824%
27/09/2000	6 531.64	0.0963%
28/09/2000	6 535 82	0.0640%
29/09/2000	6 533.96	-0.0285%
02/10/2000	6 549.68	0 2403%
03/10/2000	6 551.55	0.0285%
04/10/2000	6 564.00	0 1899%
05/10/2000	6 576.50	0.1903%
06/10/2000	6 579.91	0.0518%
09/10/2000	6 589.32	0.1429%
10/10/2000	6 596.09	0.1027%
11/10/2000	6 606.23	0 1536%
12/10/2000	6 609.41	0 0481%
13/10/2000	6 621.96	0.1897%
16/10/2000	6 632.69	0.1619%
17/10/2000	6 625.50	-0.1085%
18/10/2000	6 627.09	0.0240%
19/10/2000	6 633.14	0.0913%

20/10/2000	6 649.64	0.2484%
23/10/2000	6 655.59	0.0894%
24/10/2000	6 656.18	0.0089%
25/10/2000	6 669.87	0.2055%
26/10/2000	6 675.68	0.0871%
27/10/2000	6 675.68	0 0000%
30/10/2000	6 674.62	-0.0159%
31/10/2000	6 674.78	0.0024%
01/11/2000	6 703.86	0.4347%
02/11/2000	6 701.59	-0 0339%
03/11/2000	6 714.91	0.1986%
06/11/2000	6 714 91	0.0000%
07/11/2000	6 723.86	0.1332%
08/11/2000	6 740.45	0 2464%
09/11/2000	6 750.14	0.1437%
10/11/2000	6 755.59	0.0807%
13/11/2000	6 759.28	0.0546%
14/11/2000	6 773.28	0.2069%
15/11/2000	6 774.55	0.0187%
16/11/2000	6 778.96	0.0651%
17/11/2000	6 781.41	0.0361%
20/11/2000	6 782.09	0.0100%
21/11/2000	6 799 41	0.2551%
22/11/2000	6 800.96	0.0228%
23/11/2000	6 811.14	0.1496%
24/11/2000	6 813.78	0.0388%
27/11/2000	6 820.60	0.1000%
28/11/2000	6 825.78	0.0759%
29/11/2000	6 828.05	0.0333%
30/11/2000	6 828.23	0.0026%
04/12/2000	6 834.59	0.0931%
05/12/2000	6 840.64	0.0885%
06/12/2000	6 856.64	0.2336%
07/12/2000	6 858.55	0.0279%
08/12/2000	6 862.59	0.0589%
11/12/2000	6 867.73	0.0749%
12/12/2000	6 868.64	0.0132%
13/12/2000	6 870.09	0.0211%
14/12/2000	6 871.59	0.0218%
15/12/2000	6 874.91	0.0483%
18/12/2000	6 877.68	0 0403%
19/12/2000	6 877.05	-0.0092%
20/12/2000	6 881.37	0 0628%
21/12/2000	6 882.87	0.0218%
22/12/2000	6 884.37	0.0218%
28/12/2000	6 886.78	0.0350%
29/12/2000	6 889.28	0 0363%
02/01/2001	6 892 00	0.0395%
03/01/2001	6 894.05	0.0297%
04/01/2001	6 903.32	0.1344%
05/01/2001	6 906.91	0.0520%

08/01/2001	6 908.09	0.0171%
09/01/2001	6 912.78	0.0679%
10/01/2001	6 999.59	1.2480%
11/01/2001	6 991.55	-0.1149%
12/01/2001	6 888.55	-1.4842%
15/01/2001	6 892.69	0.0601%
16/01/2001	6 897.78	0.0738%
17/01/2001	6 895.76	-0.0293%
18/01/2001	6 892.59	-0.0460%
19/01/2001	6 891.37	-0.0177%
22/01/2001	6 891.28	-0.0013%
23/01/2001	6 891.28	0.0000%
24/01/2001	6 891.28	0.0000%
25/01/2001	6 891.28	0.0000%
26/01/2001	6 889.00	-0.0331%
29/01/2001	6 889.00	0.0000%
30/01/2001	6 897.87	0.1287%
31/01/2001	6 898.68	0.0117%
01/02/2001	6 907.37	0.1259%
02/02/2001	6 908.87	0.0217%
05/02/2001	6 909.00	0.0019%
06/02/2001	6 909.00	0.0000%
07/02/2001	6 911.50	0.0362%
08/02/2001	6 914.00	0.0362%
09/02/2001	6 914.50	0.0072%
12/02/2001	6 919.73	0.0756%
13/02/2001	6 922.46	0.0394%
14/02/2001	6 937.73	0.2203%
15/02/2001	6 952.78	0.2167%
16/02/2001	6 954.14	0.0196%
19/02/2001	6 961.05	0.0993%
20/02/2001	6 977.59	0.2373%
21/02/2001	6 987.27	0.1386%
22/02/2001	6 991.77	0.0644%
23/02/2001	6 997.64	0.0839%
26/02/2001	7 000.46	0.0403%
27/02/2001	7 005.27	0.0687%
28/02/2001	7 015.18	0.1414%
01/03/2001	7 020.64	0.0778%
02/03/2001	7 026.59	0.0847%
07/03/2001	7 026.59	0.0000%
08/03/2001	7 042.82	0.2307%
09/03/2001	7 050.59	0.1103%
12/03/2001	7 057.73	0.1012%
13/03/2001	7 061.55	0.0541%
14/03/2001	7 071.23	0.1370%
15/03/2001	7 082.14	0.1542%
16/03/2001	7 083.64	0.0212%
19/03/2001	7 087.37	0.0526%
20/03/2001	7 092.96	0.0788%
21/03/2001	7 093.46	0.0070%

22/03/2001	7 099.64	0.0871%
23/03/2001	7 095.64	-0.0564%
26/03/2001	7 100.28	0.0654%
27/03/2001	7 100.73	0.0063%
28/03/2001	7 100.73	0.0000%
29/03/2001	7 105.28	0 0641%
30/03/2001	7 105.73	0.0063%
02/04/2001	7 105.73	0 0000%
03/04/2001	7 105.73	0.0000%
04/04/2001	7 107.09	0.0191%
05/04/2001	7 111.77	0.0658%
06/04/2001	7 112.18	0.0058%
09/04/2001	7 117.23	0.0710%
10/04/2001	7 122.28	0.0709%
11/04/2001	7 120.91	-0.0192%
12/04/2001	7 120.78	-0.0018%
17/04/2001	7 120.78	0 0000%
18/04/2001	7 122.14	0.0191%
19/04/2001	7 122.23	0.0013%
20/04/2001	7 126.78	0.0639%
23/04/2001	7 127.23	0 0063%
24/04/2001	7 127.23	0.0000%
25/04/2001	7 134.05	0.0956%
26/04/2001	7 134.68	0.0088%
27/04/2001	7 134.68	0.0000%
30/04/2001	7 139.73	0 0708%
02/05/2001	7 142.46	0.0382%
03/05/2001	7 142.46	0.0000%
04/05/2001	7 142 73	0.0038%
07/05/2001	7 142 73	0.0000%
08/05/2001	7 147.28	0.0637%
09/05/2001	7 147.73	0.0063%
10/05/2001	7 147.73	0.0000%
11/05/2001	7 147.73	0.0000%
14/05/2001	7 147.50	-0.0032%
15/05/2001	7 147.73	0.0032%
16/05/2001	7 148 18	0.0063%
17/05/2001	7 148 23	0.0007%
18/05/2001	7 150 05	0.0255%
21/05/2001	7 150.23	0.0025%
22/05/2001	7 148.41	-0.0255%
23/05/2001	7 148.28	-0.0018%
24/05/2001	7 150.09	0.0253%
25/05/2001	7 150 68	0.0083%
28/05/2001	7 150.73	0.0007%
29/05/2001	7 150 73	0.0000%
30/05/2001	7 150.73	0.0000%
31/05/2001	7 150.73	0.0000%
01/06/2001	7 149.82	-0 0127%
04/06/2001	7 154 32	0.0629%
05/06/2001	7 155 64	0.0184%

06/06/2001	7 155.73	0.0013%
07/06/2001	7 162.55	0.0953%
08/06/2001	7 163.23	0.0095%
11/06/2001	7 163.68	0.0063%
12/06/2001	7 163.68	0.0000%
13/06/2001	7 163.68	0.0000%
14/06/2001	7 165.09	0.0197%
15/06/2001	7 154.32	-0 1504%
18/06/2001	7 153.32	-0.0140%
19/06/2001	7 146 45	-0 0961%
20/06/2001	7 145.78	-0.0094%
21/06/2001	7 145.78	0 0000%
22/06/2001	7 148.50	0.0381%
25/06/2001	7 148.73	0.0032%
26/06/2001	7 148.28	-0.0063%
27/06/2001	7 148.73	0.0063%
28/06/2001	7 150.09	0.0190%
29/06/2001	7 149.31	-0.0109%
03/07/2001	7 145.59	-0.0520%
04/07/2001	7 150.23	0.0649%
05/07/2001	7 147 95	-0.0319%
06/07/2001	7 137.82	-0.1418%
09/07/2001	7 141.87	0.0567%
10/07/2001	7 136.78	-0.0713%
11/07/2001	7 126 77	-0.1404%
12/07/2001	7 111.18	-0.2190%
13/07/2001	7 111.18	0.0000%
16/07/2001	7 113.96	0.0391%
17/07/2001	7 109.23	-0.0665%
18/07/2001	7 105 59	-0.0512%
19/07/2001	7 105.28	-0.0044%
20/07/2001	7 116.64	0.1598%
23/07/2001	7 116.28	-0.0051%
24/07/2001	7 114.00	-0.0320%
25/07/2001	7 112.41	-0 0224%
26/07/2001	7 112 28	-0.0018%
27/07/2001	7 112.28	0 0000%
30/07/2001	7 112 28	0.0000%
31/07/2001	7 112.28	0 0000%
01/08/2001	7 110.00	-0.0321%
02/08/2001	7 109.78	-0.0031%
03/08/2001	7 110.23	0.0063%
06/08/2001	7 110.23	0.0000%
07/08/2001	7 109.78	-0.0063%
08/08/2001	7 103.41	-0.0896%
09/08/2001	7 105.10	0.0238%
10/08/2001	7 105 28	0.0025%
13/08/2001	7 105 28	0.0000%
14/08/2001	7 108.46	0.0447%
15/08/2001	7 106 46	-0 0281%
16/08/2001	7 106.28	-0.0025%

17/08/2001	7 105.37	-0.0128%
20/08/2001	7 105.28	-0.0013%
21/08/2001	7 105.28	0.0000%
22/08/2001	7 105.28	0.0000%
23/08/2001	7 105.28	0.0000%
24/08/2001	7 105 28	0.0000%
27/08/2001	7 105.28	0.0000%
28/08/2001	7 105.28	0.0000%
29/08/2001	7 105.28	0.0000%
30/08/2001	7 105.28	0.0000%
31/08/2001	7 105.28	0.0000%
03/09/2001	7 105.28	0.0000%
04/09/2001	7 107.55	0.0319%
05/09/2001	7 107.73	0.0025%
06/09/2001	7 110.00	0.0319%
07/09/2001	7 110.00	0.0000%
10/09/2001	7 110.23	0.0032%
11/09/2001	7 107.96	-0.0319%
12/09/2001	7 105.50	-0.0346%
13/09/2001	7 102.78	-0 0383%
14/09/2001	7 096.87	-0.0832%
17/09/2001	7 096.87	0.0000%
18/09/2001	7 094.05	-0.0397%
19/09/2001	7 093.78	-0.0038%
20/09/2001	7 100.60	0.0961%
21/09/2001	7 101.23	0.0089%
24/09/2001	7 101.28	0.0007%
25/09/2001	7 101.28	0.0000%
26/09/2001	7 101.28	0.0000%
27/09/2001	7 101.28	0.0000%
28/09/2001	7 101 28	0.0000%
01/10/2001	7 101.28	0.0000%
02/10/2001	7 105.82	0.0639%
03/10/2001	7 106.23	0.0058%
04/10/2001	7 106.23	0.0000%
05/10/2001	7 101.68	-0.0640%
08/10/2001	7 105.82	0.0583%
09/10/2001	7 106.23	0.0058%
10/10/2001	7 104 18	-0.0289%
11/10/2001	7 104.00	-0.0025%
12/10/2001	7 104 00	0.0000%
15/10/2001	7 104.05	0.0007%
16/10/2001	7 104 00	-0.0007%
17/10/2001	7 104.00	0.0000%
18/10/2001	7 104 00	0.0000%
19/10/2001	7 105.82	0 0256%
22/10/2001	7 110.37	0.0640%
23/10/2001	7 111.41	0.0146%
24/10/2001	7 119 23	0.1099%
25/10/2001	7 119.23	0.0000%
26/10/2001	7 121.55	0.0326%

29/10/2001	7 121.78	0.0032%
30/10/2001	7 128.14	0.0893%
31/10/2001	7 124.64	-0.0491%
01/11/2001	7 128.82	0.0587%
02/11/2001	7 124.68	-0.0581%
05/11/2001	7 129.28	0.0645%
06/11/2001	7 129.73	0.0063%
07/11/2001	7 129.73	0.0000%
08/11/2001	7 129.73	0.0000%
09/11/2001	7 131.55	0.0255%
12/11/2001	7 135.82	0.0599%
13/11/2001	7 136.23	0.0057%
14/11/2001	7 138.96	0.0382%
15/11/2001	7 139.23	0.0038%
16/11/2001	7 139.23	0.0000%
19/11/2001	7 140.14	0.0127%
20/11/2001	7 141.14	0.0140%
21/11/2001	7 150.32	0.1285%
22/11/2001	7 156.23	0.0826%
23/11/2001	7 160.32	0.0571%
26/11/2001	7 160.73	0.0057%
27/11/2001	7 168.46	0.1079%
28/11/2001	7 174.18	0.0798%
29/11/2001	7 175.14	0.0134%
30/11/2001	7 184.32	0.1279%
03/12/2001	7 187.45	0.0436%
04/12/2001	7 189.96	0.0349%
05/12/2001	7 193.59	0.0505%
06/12/2001	7 203.32	0.1352%
10/12/2001	7 205.09	0.0246%
11/12/2001	7 218.87	0.1911%
12/12/2001	7 226.50	0.1056%
13/12/2001	7 227.64	0.0158%
14/12/2001	7 240.00	0.1709%
18/12/2001	7 241.14	0.0157%
19/12/2001	7 242.50	0.0188%
20/12/2001	7 238.18	-0.0597%
21/12/2001	7 242.73	0.0628%
24/12/2001	7 247.73	0.0690%
27/12/2001	7 253.64	0.0815%
28/12/2001	7 255.09	0.0200%
31/12/2001	7 255.23	0.0019%
02/01/2002	7 255.91	0.0094%
03/01/2002	7 255.91	0.0000%
04/01/2002	7 255.95	0.0006%
07/01/2002	7 256.18	0.0032%
08/01/2002	7 260.78	0.0634%
09/01/2002	7 261.23	0.0062%
10/01/2002	7 260.28	-0.0131%
11/01/2002	7 263.55	0.0450%
14/01/2002	7 263.73	0.0025%

15/01/2002	7 265.55	0 0251%
16/01/2002	7 266.46	0.0125%
17/01/2002	7 266.73	0.0037%
18/01/2002	7 271 28	0.0626%
21/01/2002	7 271.73	0 0062%
22/01/2002	7 271.73	0.0000%
23/01/2002	7 271.73	0.0000%
24/01/2002	7 271.73	0.0000%
25/01/2002	7 276.28	0.0626%
28/01/2002	7 278.55	0.0312%
29/01/2002	7 283.28	0.0650%
30/01/2002	7 286.46	0.0437%
31/01/2002	7 300.37	0.1907%
01/02/2002	7 301.64	0.0174%
04/02/2002	7 303.55	0.0262%
05/02/2002	7 308 28	0.0647%
06/02/2002	7 324.64	0.2236%
07/02/2002	7 339 55	0.2034%
08/02/2002	7 340.91	0.0185%
11/02/2002	7 350.91	0.1361%
12/02/2002	7 369.23	0.2489%
13/02/2002	7 371 30	0.0281%
14/02/2002	7 375.64	0.0589%
15/02/2002	7 379.23	0.0487%
18/02/2002	7 389.19	0.1349%
19/02/2002	7 390 37	0.0160%
20/02/2002	7 418.28	0.3769%
21/02/2002	7 427.64	0.1261%
25/02/2002	7 413 50	-0.1906%
26/02/2002	7 460.82	0.6363%
27/02/2002	7 467.87	0.0944%
28/02/2002	7 475.32	0.0997%
01/03/2002	7 488.73	0.1792%
04/03/2002	7 494.50	0.0770%
05/03/2002	7 510.00	0.2066%
07/03/2002	7 519.14	0.1216%
08/03/2002	7 525.41	0.0834%
11/03/2002	7 528.27	0.0380%
12/03/2002	7 553.05	0.3286%
13/03/2002	7 555 32	0.0300%
14/03/2002	7 558.73	0.0451%
15/03/2002	7 567.82	0.1202%
18/03/2002	7 571.69	0.0511%
19/03/2002	7 579.77	0.1067%
20/03/2002	7 590.00	0.1349%
21/03/2002	7 590.96	0 0126%
22/03/2002	7 593.32	0.0311%
25/03/2002	7 597 18	0.0508%
26/03/2002	7 598.41	0.0162%
27/03/2002	7 600.82	0.0317%
28/03/2002	7 605.60	0.0629%

02/04/2002	7 606.91	0.0172%
03/04/2002	7 626.14	0.2525%
04/04/2002	7 631.55	0.0709%
05/04/2002	7 638.82	0.0952%
08/04/2002	7 648.55	0.1273%
09/04/2002	7 651.77	0.0421%
10/04/2002	7 657.91	0.0802%
11/04/2002	7 659.82	0.0249%
12/04/2002	7 661.41	0.0208%
15/04/2002	7 661.41	0.0000%
16/04/2002	7 682.46	0.2744%
17/04/2002	7 684.37	0.0249%
18/04/2002	7 689.10	0.0615%
19/04/2002	7 693.18	0.0530%
22/04/2002	7 693.50	0.0042%
23/04/2002	7 699.00	0.0715%
24/04/2002	7 710.86	0.1539%
25/04/2002	7 718.27	0.0961%
26/04/2002	7 723.50	0.0677%
29/04/2002	7 738.09	0.1887%
30/04/2002	7 741.23	0.0406%
02/05/2002	7 743.37	0.0276%
03/05/2002	7 755.37	0.1549%
06/05/2002	7 758.73	0.0433%
07/05/2002	7 759.00	0.0035%
08/05/2002	7 759.50	0.0064%
09/05/2002	7 761.82	0.0299%
10/05/2002	7 762.50	0.0088%
13/05/2002	7 771.19	0.1119%
14/05/2002	7 772.91	0.0221%
15/05/2002	7 773.00	0.0012%
16/05/2002	7 781.68	0.1116%
17/05/2002	7 786.09	0.0567%
20/05/2002	7 789.69	0.0462%
21/05/2002	7 796.41	0.0862%
22/05/2002	7 804.68	0.1060%
23/05/2002	7 808.64	0.0507%
24/05/2002	7 813.55	0.0629%
28/05/2002	7 822.50	0.1145%
29/05/2002	7 830.98	0.1083%
30/05/2002	7 833.80	0.0360%
31/05/2002	7 834.05	0.0032%
03/06/2002	7 842.23	0.1044%
04/06/2002	7 846.60	0.0557%
05/06/2002	7 856.59	0.1272%
06/06/2002	7 862.00	0.0688%
07/06/2002	7 865.23	0.0411%
10/06/2002	7 870.55	0.0676%
11/06/2002	7 871.00	0.0057%
12/06/2002	7 871.50	0.0064%
13/06/2002	7 871.55	0.0006%

14/06/2002	7 878.37	0.0866%
17/06/2002	7 890.36	0.1521%
18/06/2002	7 895.96	0.0709%
19/06/2002	7 897 41	0.0184%
20/06/2002	7 901.64	0 0535%
21/06/2002	7 904.32	0.0339%
24/06/2002	7 909.10	0.0605%
25/06/2002	7 912.45	0.0423%
26/06/2002	7 916.18	0 0471%
27/06/2002	7 919.30	0.0394%
28/06/2002	7 922.41	0.0393%
02/07/2002	7 922.87	0.0058%
03/07/2002	7 930.77	0.0997%
04/07/2002	7 933.73	0.0373%
05/07/2002	7 937.69	0.0499%
08/07/2002	7 944.87	0.0904%
09/07/2002	7 947.09	0.0279%
10/07/2002	7 947.09	0.0000%
11/07/2002	7 985.91	0.4873%
12/07/2002	8 007 41	0.2689%
15/07/2002	8 014.36	0.0868%
16/07/2002	8 021.77	0.0924%
17/07/2002	8 024.73	0.0369%
18/07/2002	8 026.41	0.0209%
19/07/2002	8 026.55	0.0017%
22/07/2002	8 031.10	0.0567%
23/07/2002	8 036.10	0.0622%
24/07/2002	8 037.46	0.0170%
25/07/2002	8 064.26	0.3328%
26/07/2002	8 065.87	0.0200%
29/07/2002	8 066.05	0.0022%
30/07/2002	8 068 32	0.0281%
31/07/2002	8 075.82	0 0929%
01/08/2002	8 083.32	0.0928%
02/08/2002	8 086.23	0.0360%
05/08/2002	8 081.00	-0.0647%
06/08/2002	8 089.23	0.1018%
07/08/2002	8 090.00	0.0095%
08/08/2002	8 095.05	0.0624%
09/08/2002	8 102.14	0 0875%
12/08/2002	8 105.23	0.0381%
13/08/2002	8 105.55	0.0039%
14/08/2002	8 111.00	0.0672%
15/08/2002	8 112 59	0 0196%
16/08/2002	8 110.46	-0.0263%
19/08/2002	8 109.37	-0 0134%
20/08/2002	8 110 18	0.0100%
21/08/2002	8 111.59	0.0174%
22/08/2002	8 111.73	0.0017%
23/08/2002	8 111.73	0.0000%
26/08/2002	8 115.55	0.0471%

27/08/2002	8 116.18	0.0078%
28/08/2002	9 117.45	11 6331%
29/08/2002	8 113.57	-11.6652%
30/08/2002	8 112.00	-0.0194%
02/09/2002	8 119.23	0 0891%
03/09/2002	8 119.23	0.0000%
04/09/2002	8 119 23	0 0000%
05/09/2002	8 116.96	-0.0280%
06/09/2002	8 116 09	-0.0107%
09/09/2002	8 123.28	0.0886%
10/09/2002	8 123.96	0.0084%
11/09/2002	8 122.18	-0.0219%
12/09/2002	8 125.37	0.0393%
13/09/2002	8 125.50	0.0016%
16/09/2002	8 125 50	0.0000%
17/09/2002	8 127 78	0.0281%
18/09/2002	8 130.96	0.0391%
19/09/2002	8 133.28	0.0285%
20/09/2002	8 129.64	-0.0448%
23/09/2002	8 131 78	0.0263%
24/09/2002	8 132.00	0.0027%
25/09/2002	8 137.23	0.0643%
26/09/2002	8 141.02	0.0466%
27/09/2002	8 141.91	0 0109%
30/09/2002	8 142.41	0.0061%
01/10/2002	8 142.50	0.0011%
02/10/2002	8 147.50	0.0614%
03/10/2002	8 150.69	0.0391%
04/10/2002	8 153 28	0 0318%
07/10/2002	8 160.78	0.0919%
08/10/2002	8 163.28	0 0306%
09/10/2002	8 166.00	0.0333%
10/10/2002	8 171.45	0.0667%
11/10/2002	8 175.55	0.0502%
14/10/2002	8 184 60	0.1106%
15/10/2002	8 186.37	0.0216%
16/10/2002	8 187.87	0.0183%
17/10/2002	8 190.28	0.0294%
18/10/2002	8 193.23	0.0360%
21/10/2002	8 193.23	0.0000%
22/10/2002	8 194 41	0.0144%
23/10/2002	8 198.14	0.0455%
24/10/2002	8 204.41	0.0765%
25/10/2002	8 205.18	0.0094%
28/10/2002	8 205.68	0.0061%
29/10/2002	8 210.23	0.0554%
30/10/2002	8 215 00	0.0581%
31/10/2002	8 199.24	-0.1920%
01/11/2002	8 215 91	0.2031%
04/11/2002	8 219.09	0.0387%
05/11/2002	8 221.28	0.0266%

06/11/2002	8 222.41	0.0137%
07/11/2002	8 222.50	0.0011%
08/11/2002	8 225.23	0.0332%
11/11/2002	8 225.91	0.0083%
12/11/2002	8 227.28	0.0167%
13/11/2002	8 225 50	-0.0216%
14/11/2002	8 225.50	0 0000%
15/11/2002	8 227.96	0.0299%
18/11/2002	8 228.00	0.0005%
19/11/2002	8 232.55	0.0553%
20/11/2002	8 244.78	0 1484%
21/11/2002	8 246.82	0.0247%
22/11/2002	8 250.19	0.0409%
25/11/2002	8 250.50	0.0038%
26/11/2002	8 252.78	0.0276%
27/11/2002	8 254.37	0.0193%
28/11/2002	8 254.50	0.0016%
29/11/2002	8 258.60	0.0497%
02/12/2002	8 259.96	0.0165%
03/12/2002	8 268.59	0.1044%
04/12/2002	8 276.23	0.0924%
05/12/2002	8 279.41	0.0384%
09/12/2002	8 282.68	0.0395%
10/12/2002	8 288.41	0.0692%
11/12/2002	8 301.87	0.1623%
12/12/2002	8 313.14	0.1357%
13/12/2002	8 314 14	0.0120%
16/12/2002	8 325.37	0.1350%
17/12/2002	8 333.23	0.0944%
18/12/2002	8 336.87	0.0437%
19/12/2002	8 337 91	0.0125%
20/12/2002	8 338.68	0.0092%
23/12/2002	8 338 96	0.0034%
24/12/2002	8 345.82	0.0822%
27/12/2002	8 347.82	0.0240%
30/12/2002	8 350.73	0.0349%
31/12/2002	8 351.91	0.0141%