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The Effectiveness of Hedging Foreign Exchange Rate Risk: An Emerging Market Perspective

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DECLARATION

I, Tal Ben-David, declare that the research work reported in this dissertation is my own, except where otherwise indicated and acknowledged. It is submitted for the degree of Masters of Management in Finance and Investment at the University of Witwatersrand, Johannesburg. This thesis has not, either in whole or in part, been submitted for a degree or diploma to any other universities.

Signature of candidate _____ Date _____

Abstract

This study provides an analysis of the effectiveness of the foreign currency hedging abilities afforded by the futures market. The focus is on the currencies of six emerging markets, namely; Brazil, India, Mexico, Russia, South Africa and Turkey. By examining emerging market currencies we can examine the effect that possible mispricing and lack of liquidity can have on hedging effectiveness. To this effect, this article uses the regression method, as allowed by the accounting standard FAS 133, to assess the effectiveness of futures contracts as a hedging mechanism for emerging market currencies. The methods follow previous studies such as Hill and Schneeweis (1982) which consider the length of the hedging horizon and time to expiration due to their effect on hedge effectiveness. Results indicate consistent hedge effectiveness in only South Africa and Turkey, with reasonable hedge effectiveness exhibited by Mexico and Russia. Sensible explanations are given for the extreme hedge ineffectiveness that can be seen in the Brazilian and Indian tests.

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1 Introduction

"Hedging Provides certainty…of death", "The only perfect hedge is in a Japanese garden".

The above are quotes from Satyajit Das (2006) in his highly acclaimed yet controversial book "Traders, Guns & Money" and from Gene Rotberg a former advisor to the World Bank. Although these statements are exaggerations, this thesis will examine the possible complications and negative effects that may arise from the hedging of foreign exchange rate exposure. The complications that may arise are even more noticeable in emerging markets where financial markets are much smaller and less developed.

Hedging transfers risk, in our case foreign exchange risk, from market participants wishing to avoid it to those willing to assume it. In principle a hedge is effective if it eliminates the cash flow uncertainty or price risk associated with a future transaction. This is achieved when the changes in fair value or cash flow of the hedged item and the hedging derivative offset each other to a significant extent. In other words the hedging contracts change in value is opposite to the change in value of the currency exposure. These two amounts offset each other so that the hedger can obtain revenue or cost certainty. According to the accounting standard FAS 133[1], there are various ways to test for hedge effectiveness. This thesis will focus on one of the methods known as the regression method. The Regression Method uses regression analysis to test for an R^2 of at least 80% in order for a hedge to be considered effective. R^2 refers to the variance in the hedging instrument that is explained by the variance in the hedged item or underlying (Finnerty & Grant, 2003).

The era of floating exchange rates that began in 1973 along with increased globalisation and international trade, spurred the need for currency derivatives to hedge exchange rate risk. Foreign exchange rate instability can influence the corporation's performance in terms of cash flows, net income, balance sheet figures and therefore the firm's ultimate value. The Bank for International Settlements (BIS) shows the notional value of foreign exchange contracts in 2008 to be a staggering $49.8 trillion. Moreover a survey by the International Swaps and Derivatives Association in 2003 found that 85% of the world's 500 largest companies use derivatives to manage currency risk (Sundaram & Das, 2010).

[1] "Financial Accounting Standard (FAS) 133 requires business entities to document their anticipation of hedge effectiveness in order to qualify for hedge accounting treatment of gains and losses from financial derivatives" (Charnes, Koch, & Berkman, 2003).

The competitiveness of today's business world means that expanding globally is necessary for continued growth. The rapidly growing populations and consumer spending of emerging economies present extraordinary growth opportunities for business expansion and diversification. However the success of international business is to a large extent tied to exchange rate volatility that any global business will encounter. Gray and Irwin (2003) broadly divide exchange rate risk into two categories: project related or financing related. Project exchange rate risk arises when the price of the project's inputs or outputs are influenced by the exchange rate. Financing exchange rate risk most commonly involves loans requiring repayment at a future date in a foreign currency.

The most fundamental debate is on whether corporations should hedge at all. This debate has been well documented and the accepted understanding is that corporations can add value by hedging (McCarthy, 2003). McCarthy (2003) also concludes that while hedging is recommended it is often superior not to hedge at all and that the decision depends on the currency in question.

1.1 Problem Statement

The popularity and logical reasons for hedging foreign exchange rate risk is clear. However the effectiveness of hedging strategies in emerging markets is not as clear cut. The possible problems that might arise from attempts to hedge using futures contracts that are being tested in this article are:

- If a suitable futures market exists for the currency, will the illiquidity in the futures market mean that the futures price will not be sufficiently correlated to the underlying currency and thus mean an ineffective hedge. In other words, will mispricing of the futures contracts occur and will this create an ineffective hedge? Similarly, another consequence of illiquidity is the limited range of maturity dates available for futures contracts. As a result the investors' date of market commitment will often not coincide with the available maturity dates. The mismatch in maturity dates is referred to as delivery basis risk. Delivery basis risk implies that the hedge will not be perfect (Sundaram & Das, 2010).

It is important to keep in mind that in the extreme case of zero correlation between spot and futures price changes, there is no offsetting of risks at all from hedging using futures contracts. Any hedging activity will only increase overall cash flow and price risk by creating

uncertainty from a second source, namely the futures position. It is only when the correlation of spot and futures price changes are perfect[2] (no basis risk) that a riskless hedge is obtained without the use of an optimal hedge ratio[3] (Sundaram & Das, 2010). It will also be shown that the effectiveness of the hedge is tied to the correlation between the spot and futures price changes and the minimum variance hedge ratio.

Although Forward markets can help to eliminate the above problems and for that reason are the most popular contracts used for hedging purposes, hedging with forwards also has its disadvantages. Most noticeably, finding a counter-party can be a lengthy process and potentially costly. Forwards are less liquid in that if the need to remove the hedge arises forwards cannot be sold prior to expiration. Moreover futures, unlike forwards, provide leverage and therefore with futures it is possible to hedge a big amount with a smaller outlay.

This thesis will therefore focus on futures as a form of hedging. However, further on the reader is made aware that when a hedging programme is implemented, it is imperative that the firm knows the extent to which its competitor's hedge currency risks. This awareness also has an impact on hedging strategies that use forward contracts. A major problem of hedging with futures is that they are marked-to-market, making it almost impossible to hedge cash flows and values simultaneously (Mello & Parsons, 2000). For example, a futures contract that locked in the value of the Rand in a years' time would generate an uncertain cash flow pattern over the next year (even though the economic value of the position remains hedged) due to the margin account being marked-to-market daily.

An important assumption taken into account in this thesis is the assumption of passive hedging. The corporations are assumed to have no view of future spot rates and therefore are not interested in tactical hedging programs. The corporations are only concerned about risk reduction and not any risk-return relationship. Often improving the risk-return relationship through hedging is an objective for globally diversified equity portfolios. This thesis therefore does not specifically apply to these forms of investment management corporations; i.e., financial services firms are not part of the sample in this study.

[2] "In the presence of basis risk, it is not generally optimal to hedge exposures one-for-one. The variance minimizing hedge ratio depends on the correlation between spot and futures price changes and increases as this correlation increases (Sundaram & Das, 2010)"

[3] The minimum variance hedge ratio identifies the hedge that leads to the least cash flow variance among all possible hedges (Sundaram & Das, 2010). It is also referred to as the optimal hedge ratio.

This study is also limited in scope to an analysis of single currency hedges. The strategy of minimising currency risks on portfolios of spot currencies is not analysed (e.g., a firm that exports to many countries and faces simultaneous foreign exchange rate risk in all the currencies). However a simple rule is to identify the optimal hedge ratio for each risk separately and add them all up to obtain the optimal portfolio hedge (Sundaram & Das, 2010).

1.2 Significance of study

Kawaller (2012) points out that there is a critical difference between a corporation choosing not to hedge and electing not to hedge by default. Electing not to hedge due to the problems mentioned above is justified and understandable while choosing not to hedge by default is an abrogation of management's fiduciary responsibility. Selecting the appropriate hedging program for a firm exposed to currency risk is therefore imperative. Hedges that are entered into without proper knowledge of the implemented hedging strategies likely effectiveness often incur unnecessary costs, loss of market competiveness if prices move in favour of the industry and puts pressure on the firm's cash flow throughout the hedge's life because of interim margin obligations.

In extreme cases what the corporation determines to be a profitable venture turns out to be a loss generating activity due to the large fluctuations that are possible in the currency market. Therefore the firm should always try reducing currency risk so that they are able to focus on the activities of which they are expert providers. Campello, Lin, Ma, and Zou (2011) find that the correct hedging policies can lower the odds of negative firm realisations, i.e., profits and cash flow variability. This in turn reduces the odds of expected financial distress. This in turn allows hedgers to pay lower interest spreads and thus these corporations have more opportunities for capital expenditure.

New accounting standards in the form of IFRS 9 are expected to replace FAS 133 (the current standard that regulates which firms may apply hedge accounting). There are many benefits for a firm to apply hedge accounting. The new IFRS 9 states that establishing hedge effectiveness in order to qualify for hedge accounting no longer needs to be proved by quantitative methods only but can now also be proved by qualitative methods (Deloitte & Touche, 2011). This study's outcome may help as a qualitative and quantitative proof of what may be considered an effective hedge in an emerging market context.

Lastly, Dale (1981) notes that the effectiveness of hedging with futures contracts is important for two reasons. First, hedgers are necessary to maintain the long term viability of most currency futures market. He elaborates on this point and provides evidence to show that essentially duplicative futures contract have a high failure rate. This implies that it is in the best interest of market markers to provide futures contracts that have an economic justification (can be used as an effective hedging instrument). Second, the use of futures contracts by more importers and exporters will ultimately result in an increase in the volume of international trade. Dale (1981) further points out that a foreign firm will maximise its output when the firm knows that there is a financial market available in which the firm can virtually eliminate its foreign exchange risk through an effective hedge.

1.3 Background literature

Mello and Parsons (2000) examine how hedging can lower the effective cost of the firm's financial constraints. They conclude that hedging improves financial flexibility, eases the costs of financial distress and allows the firm to take better advantage of investment prospects. Campello et al. (2011) provide new insight into the importance of corporate hedging by examining two channels through which hedging affects corporate outcomes. Firstly the effects of hedging policies on the firm's access to capital and second by the firm's ability to invest. They find that once hedging programs are in place, firms pay lower interest rates on loans and have fewer covenants restricting their investments. Effective hedging ultimately translates into gains for all corporate stakeholders and will likely be reflected in firm valuation.

Hill and Schneeweis (1982) examined futures contracts on five currencies. They found that the British Pound, German Mark and Swiss Franc consistently exhibit high hedging effectiveness. Whereas they found the Japanese Yen and Canadian Dollar futures contracts to be an inferior way of hedging although they do provide risk reduction compared to a completely unhedged position. Moreover it is shown that hedging effectiveness is weakest for the shortest durations (one week) and improves with longer hedging horizons.

McCarthy (2003) found that while exposure to the Australian Dollar can be effectively hedged, it is preferable to leave exposure to the Singapore Dollar and Japanese Yen unhedged. Hill and Schneeweis (1982) and McCarthy (2003) both use methods similar to the ones being used in this thesis to test for hedge effectiveness i.e. the effectiveness is tied to the

correlation between the spot and futures price changes and the minimum variance hedge ratio.

Dale (1981) however finds very different results to Hill and Schneeweis (1982) in both the minimum variance hedge ratios and hedge effectiveness tests. Both authors analyse similar time periods and hedging intervals. Hill and Schneeweis (1982) find the Japanese Yen futures contract to be an inferior hedging instrument while Dale finds it to be highly effective.

Hill and Schneeweis (1981) point out the reason for this is that Dale uses spot and futures price levels where as they used spot and futures price changes. Theoretical and statistical problems occur when testing hedge effectiveness using price levels. The object of hedging is to reduce the firms exposure to exchange rate *changes,* therefore examining hedge effectiveness and hedge ratios using *levels* will lead to errors. Moreover using price levels in regression analysis means using variables that are nonstationary and this will lead to spurious regression results.

It is clear that all the above currencies that have just been discussed belong to developed countries while this thesis relates to under-developed emerging currencies. However the above examination gives all the more reason to examine currencies of under developed currencies if hedging strategies involving well developed financial markets have been proven to be inefficient on occasion.

Emerging markets are more prone to currency crisis or volatile movements and any exposure to these currencies would make a hedging strategy seem wise. However, for many emerging markets there are no exchange traded derivative products available. Therefore the only option becomes to hedge using another asset/contract, i.e., cross-hedging which provides an alternative to costly over the counter solutions (Bowman, 2004). Bowman (2004) defines a cross-hedge as involving the purchase of a futures contract in an asset other than that which makes up the currency spot exposure and that differs from the spot exposure in location, type or maturity date. A cross-hedge thus typically eliminates a smaller proportion of risk than a direct hedge but allows the hedge to be created with the benefits of liquidity and lower premiums. Bowman also defines an effective cross-hedging instrument as one that is strongly related to the asset being hedged, and correlation statistics are an indicator of this relationship. Bowman (2004) finds that in the case of East Asian emerging markets, the practice of cross-hedging generally benefits an emerging market currency exposure when the alternative is an unhedged spot exposure. Eaker and Grant (1987) also find that cross-

hedging provides opportunities for risk reduction in non-traded currencies and the effectiveness of cross hedging strategies depends upon the successful identification of a highly correlated substitute asset.

A problem dealt with in this article is that of financial market under-development, illiquidity and mispricing. Merrick (1988) mentions that mispricing in derivative contracts have an important implication for hedging market positions. Merrick notes that the causes for possible mispricing can be attributed to transaction costs, immaturity of the arbitrage sector, market liquidity differences and general market inefficiency. Further, the implication of the lack of maturity dates available because of the illiquidity is that it is likely hedges will not be held to expiration and therefore, according to Merrick, the hedge will not be riskless. Finally Merrick concludes that there are methods available to adapt hedging techniques and hedge ratios to account for the mispricing, he shows these to work well on stock index futures. However these techniques will not be tested in this thesis, rather this thesis will only examine the effect of the illiquidity and mispricing on hedge effectiveness and not the solutions to hedge with mispriced futures contracts.

Choi (2009) confirms that difficulties are encountered when hedging for minor currencies. He defines minor currencies as those traded in illiquid markets. He states that in the case of minor currencies few seem to pass the threshold of hedge effectiveness well, although some minor currencies still seem to be an effective hedge.

1.4 Overview of research methodology

A regression Analysis of the futures contracts price changes with the spot currency price changes will be performed, with the R^2 being the particular statistic of interest as it indicates the effectiveness of the hedge. Hill and Schneeweis (1981) show that the duration of the hedge contract has an impact on the effectiveness of the hedge. Short term hedges such as one week are often not very effective while longer term hedges of nine to twelve months become very effective. For this reason testing will take place for three different durations: short term hedges of one week, medium term hedges of four weeks and long term hedges of 12 months. Moreover, following the methods used by Hill and Schneeweis (1982) who note that since time to delivery may affect the minimum hedge ratio and hedging effectiveness, the effectiveness of the hedge durations above are examined with contracts separated into four, three month periods, representing time to delivery, ranging from 0-3 months from expiration

date of the futures contract (being the closest to delivery) and 9-12 months from the expiration date of the futures contract.

1.5 Outline of the Study

Aside from the obvious advantage of the hedge eliminating price uncertainty, other interesting implications of corporate hedging will be discussed. Next, formal definitions of the different hedging instruments and methods will be listed along with the advantages and disadvantages of each. Moreover specific hedging issues pertinent to emerging markets will be discussed such as cross hedging due to the unavailability of the exact futures contracts needed. Furthermore, the need for knowing to what extent other competitors hedge their foreign exchange rate risk will be discussed in detail.

The in depth analysis will begin with a critical evaluation of previous studies regarding the effectiveness of hedging foreign exchange rate risk. Previous results will be analysed and pitfalls or problems with interpreting such results naively will be discussed. Moreover the different methods that can be used to test hedge effectiveness are mentioned and the reasoning for using the regression method will be stated. Any assumptions, problems and omitted factors have been mentioned in the problem statement above.

The quantitative calculations on six emerging market currencies including South Africa will then be performed to test hedge effectiveness using the regression method. Multiple tests for each country will be performed in order to take into account the length of the hedge and time to maturity. Results will be compared to the results of previous studies on both developed and emerging markets.

2 The Implications of Corporate Hedging

Mello and Parsons (2000) examine how hedging can lower the effective cost of the firm's financial constraints. Using a dynamic model of the firms operations and financial policies, they conclude that hedging improves financial flexibility, eases the costs of financial distress and allows the firm to take better advantage of investment prospects. Campello et al. (2011) record similar findings, they find that the correct hedging policies can lower the odds of negative firm realisations; i.e., lower profits and cash flow variability. This in turn reduces the odds of expected financial distress. They find that this allows hedgers to pay lower interest spreads and thus these corporations have more opportunities for capital expenditure. This ultimately translates into gains for all corporate stakeholders and will likely be reflected in firm valuation.

However, Bali, Hume, and Martell (2007) look at the impact of hedging on the firms market risk. They mention that although theory suggests hedging with derivatives is expected to improve a firms cost of capital and ultimately its stock price, evidence has been weak in terms of finding a positive correlation between hedging currency risk and a firms stock price. In fact their results indicate that there is a weak relationship between a firm's use of hedging with derivatives and the firms risk exposure (Currency, interest rate and commodity risk). This finding is surprising given the size of the derivatives market today. They conclude that large and efficient non-financial firms that are well diversified geographically do not have a strong economic justification for most derivative hedging programs. The market risk for these types of firms does not justify the transactional and operational costs of hedging programs using derivatives.

It is argued by Ross (1998) that optimal hedging does not ultimately lead to a decrease in financial distress but rather optimal hedging provides for increased leverage and the tax benefits that follow. Ross (1998) demonstrates that optimal hedging can result in a firm reaching its optimum capital structure. This can translate into an increase of firm value of between 10%-15%. However Ross (1998) defines optimal hedging to mean the hedging of the firms' market value of assets. Individual risk hedging such as that of foreign exchange rate risk is just a means to that end.

To conclude the discussion on the implications of corporate hedging, Nance, Smith Jr, and Smithson (1993) insist and provide evidence to the end that hedging should continue to be

seen as a critical component of a firm's financial policies. They too find that proper hedging strategies reduce expected tax liabilities and lower the expected costs of financial distress.

3 An Overview of Hedging Instruments and Other Hedging Methods

3.1 Basic Terms and Principles

In this section formal definitions of the main hedging instruments available to currency hedgers will be listed each with their important common features and the consequential advantages and disadvantages of each instrument when used as a hedging tool. Other hedging methods that do not necessarily involve the corporation itself or derivative products will also be discussed.

The following basic terms are provided and apply to forward, futures and option contracts:

- *Long position:* The buying of a security or currency with an expectation that the value of the asset will rise. In the context of derivatives, it is the buying of a derivative contract. The long position agrees to buy the underlying asset at the specified price on the specified date.
- *Short position:* In the context of derivatives, the seller or writer of the contract is said to have a short position. The short position agrees to sell the underlying asset at the specified price on the specified date.
- *Underlying asset:* The asset/ currency specified in the contract.
- *Maturity date:* The specified date on which the trade will take place or the date of expiration of the contract.
- *Delivery price/ Exercise price:* The price specified in the contract at which the specified trade of the underlying contract will take place.

The two hedge positions that can be entered into are detailed below:

- *Short Hedge:* Involves taking a short position in a derivative contract. A short hedge is appropriate when the hedger currently owns the asset/currency and expects to sell it in the future (short spot exposure). A short hedge will also be used when the currency is not currently owned but the hedger expects to own it at some point in the future. For example a South African exporter that knows he or she will receive US Dollars (USD) in three months will realise a gain if the USD increases in value relative to the South African Rand (ZAR) but will realise a loss if the USD decreases in value

relative to the ZAR. Taking a short position on the USD will have the effect of offsetting the exporters' risk. The short position will lead to a loss when the USD strengthens against the ZAR offsetting the gain in the spot market. Similarly the short position will lead to a gain when the USD weakens against the ZAR offsetting the loss in the spot market (Hull, 2009). To emphasise it is this theoretical perfect offsetting of risk due to the equal and opposite movements of the spot and futures contracts that this article is testing. The above hedge would not be effective and would not offset the desired risk should the price movements of the USD/ZAR futures contract not be closely correlated with the movement in the spot market of the USD/ZAR rates.

- *Long hedge:* Involves taking a long position in a derivative contract. A long hedge is appropriate when the corporation knows it will have to purchase an asset in the future and wants to lock in the price now (long spot exposure). In the case of this research article we are only concerned with locking in the price of the exchange rate should the asset be quoted in a foreign currency.

The above short or long hedge positions are generally appropriate for the situations or type of exposure detailed above. However it is important to note that it is the sign of the minimum variance hedge ratio that will sometimes determine whether it is a long or short hedge position that should be entered into. This can be contrary to the appropriate positions described above. The sign of the minimum variance hedge ratio is determined by the correlation between spot price changes and the futures contract price changes. The minimum variance hedge ratio will be discussed at length further on.

For the sake of clarity if the correlation between spot and futures price changes is positive, the hedge ratio is positive. This means that if the hedger has a long spot exposure (purchase commitment), he/she must take a long futures position. If he/she has a short spot exposure (Commitment to sell) he/she must take a short futures position. This is the normal state of affairs and is a summary of the two hedge positions described above. However if the correlation between spot and futures price changes is negative, the hedge ratio is negative. Meaning he/she must hedge a long spot exposure with a short futures position, and a short spot exposure with a long futures position.

3.2 Hedging with Forwards

"A forward contract is an agreement between two parties to trade in a specified quantity of a specified good at a specified price on a specified date in the future" (Sundaram & Das, 2010). The main purpose for entering into a forward contract is for hedging purposes however they can also be used for speculation. Forwards are traded on the Over-The-Counter (OTC) market whereas Futures are traded on an organised exchange and as such differ from Futures in a variety of ways.

The advantage of a forward contract being traded on the OTC market is that it is a two-sided contract and the terms of the contract are negotiated directly between the buyer and seller. As such the forward contract is customizable and can be designed to meet the specific needs of the buyer or seller. This makes forwards the most popular contract for hedging foreign exchange rate risk as it eliminates both the delivery basis risk problem[4] and the problem of having an ineffective hedge due to the lack of correlation that may be present between the change in futures price movements and the change in spot price movements.

However being traded on the OTC market also creates a disadvantage in that there is now default risk for both parties since there is no exchange to guarantee performance. Moreover neither party can walk away individually from the contract or transfer the contract individually to a third party, this makes forwards less liquid in that if the need to remove the hedge arises forwards cannot be sold prior to expiration. Futures unlike forwards provide leverage and therefore with futures it is possible to hedge a big amount with a smaller outlay.

Lastly finding counter-party for a forward contract can be a lengthy process and potentially costly. Dale (1981) expands on this limitation in that banks would usually limit its sales of forward contracts to its biggest and most credit worthy customers.

3.3 Hedging with Futures

A futures contract is in principle a forward contract traded on an organised exchange. While forwards and futures serve the same purpose and are functionally similar, the association of an exchange in the futures market creates some differences between them. To make trading

[4] Delivery basis risk or delivery date mismatch occurs since futures contracts have standardized maturity dates which may not coincide with the investors date of market commitment (Sundaram & Das, 2010).

possible the features of a futures contract must be standardized since the buyer and seller never meet (Sundaram & Das, 2010).

The involvement of an exchange and standardization makes the futures market more liquid then the forward market. The exchange also guarantees performance of the contract and buyers and sellers are not exposed to default risk, parties are exposed only to the default risk of the exchange which in reality is very low. The biggest advantage is the ability to close out or reverse a futures position any time prior to expiration. Closing out simply involves taking an opposite position to the original one.

As mentioned earlier the biggest disadvantage of the futures contract is the standardization created by the exchange and the likelihood of delivery basis risk or delivery date mismatches. Since futures can be traded on a daily basis this can also create an ineffective hedge due to the lack correlation between the futures price changes and spot market price changes, this is often caused by speculators in the futures market, causing more price volatility than can be justified on economic grounds (Dale, 1981). A major problem of hedging with futures is that they are marked-to-market making it almost impossible to hedge cash flows and values simultaneously (Mello & Parsons, 2000). For example, a futures contract that locked in the value of the Rand in a years' time would generate an uncertain cash flow pattern over the next year even though the economic value of the position remains hedged due to the margin account being marked-to-market daily. This can cause a significant cash flow burden on hedgers.

3.4 Hedging with Options

"An option is a financial security that gives the buyer the right but not the obligation to buy or sell a specified asset at a specified price on or before a specified date"(Sundaram & Das, 2010). While the buyer enjoys the right but not the obligation to exercise the option the seller has an obligation to fulfil the options contract in the event the buyer chooses to exercise the option. There are two types of options, a call option which gives the holder the right to buy a specified asset on or before a certain date at a set price, a put option which gives the holder the right to sell the specified asset on or before a certain date for a set price. Options are also distinguished by when the right must be exercised. In a European Style option the right may only be exercised on the maturity date. In an American style option the right may be exercised any time before the maturity of the contract. Since an option comes with the right

but not the obligation, the holder of the option will only exercise the right when it is in his best interest to do so. Therefore options are in essence a form of financial insurance and the seller of the option must be compensated for giving such a right. The compensation is called the premium and is an upfront payment to the writer.

In hedging, calls are purchased if the risk is an upward trend in price, whereas puts are purchased if the risk is a downward trend in price. Options are especially useful for hedging provisional cash flows. For example a firm that bids for an overseas project that involves foreign exchange rate risk, may at the same time purchase put options to protect itself from a depreciation of the foreign currency. If the bidding was successful the firm would be protected from the downside risk while still standing to gain from an appreciation of the foreign currency. If the bid failed the firm can choose to let the options expire should the foreign currency appreciate and will lose a maximum of the premiums paid to purchase the options (Meera, 2002).

This brings us to the important advantages of using option contracts for hedging purposes. Unlike futures and forwards, options allow one to be protected from downside risk while still enjoying possible upside benefits. Moreover options are not marked-to-market and thus do not have daily margin requirements; this can potentially provide the firm with serious cash flow relief. The disadvantage arises in the cost of option premiums that are often more expensive then forwards or futures due to the financial insurance provided.

3.5 Money Market Hedge

The idea behind a money market hedge is to lock in the current spot rate for a company with future payables or receivables in a foreign currency. The technique for a money market hedge differs slightly for foreign currency receivable and foreign currency payable. In brief, money market hedging of receivables involves borrowing in the foreign currency[5], converting to the home currency and investing the home currency in the domestic money market. When the loan matures the firm will satisfy the loan using the foreign currency receivable. Money market hedging of payables involves borrowing in the home currency[6]. Converting to the

[5] The amount of foreign currency borrowed will actually be the present value of the amount receivable discounted at the current borrowing rate. Moreover the duration of the loan should be matched to the date the amount receivable becomes due.

[6] The firm must borrow an amount equal to the present value of the amount payable discounted at the foreign investment rate. Moreover the duration of the investment should be matched to the date the amount payable becomes due.

foreign currency and investing the foreign currency in the foreign money market. When the investment matures the firm will satisfy its obligations using the investment proceeds.

The cost of a money market hedge is the difference between the borrowing interest rate and investment interest rate. A money market hedge will often yield a similar result to a hedge using a forward or futures since forwards are priced to reflect the interest rate differentials between the two countries involved. In fact the cost of the money market hedge should be the same as the forward or futures market hedge, unless the firm has some advantage in one market or the other (Giddy & Dufey, 2012).

The money market hedge is often best suited for companies who have to borrow anyway. Therefore it is simply a matter of borrowing in the currency to which the company is exposed too. However if the firm wishes to borrow purely to implement a money market hedge, this is often more costly then hedging with forwards or futures since the firm may need to pay larger spreads between borrowing and investing then the spreads priced into forwards and futures prices (Giddy & Dufey, 2012).

3.6 Currency Swaps

A currency swap is an agreement which involves an exchange of interest payments and notional or principal amounts in different currencies. Currency swaps are generally used to access a cheaper source of financing in the desired foreign currency without having to access foreign capital markets. A higher cost of debt for a firm in a foreign capital market is frequently higher than the cost of debt that can be achieved by a local firm. The advantage of a currency swap is that there are no upfront costs. The disadvantage is that the firm is often exposed to the risk of default, not only on the principal amounts but also on any interest payments, if such payments are involved.

The simplest currency swap involves the exchange of only the notional amount with the other counterparty at a specified point in the future at a rate agreed now. This type of currency swap performs a function comparable to a forward or future contract. The cost of finding a counterparty and drafting of the terms with them, mostly done through a financial intermediary, often makes swaps more expensive than other derivatives and therefore are not often used to hedge shorter term currency risk. However for longer term currency risks where other derivatives are less liquid and thus have wider spreads, currency swaps are often used as a cost-effective way to hedge long term currency risk.

3.7 Other Hedging Methods

3.7.1 Shareholder Hedging

An argument often put forward against corporations hedging is that shareholders can do the hedging themselves should they wish to do so. This argument is not very sound as it assumes that all shareholders have the same access to information as do the management of the firm. In most instances shareholders do not have the same level of knowledge about the risks facing the firm as the knowledge management have. The argument does also not take into account the economy of scale pertinent to transaction and commission costs. Hedging is likely to be less expensive when carried out by the firm as opposed to individual shareholders (Hull, 2009).

However shareholders can become largely immune to the currency risk that a particular firm is exposed to far more easily than the firm can. For example, a well-diversified portfolio will in addition to containing stocks of largely export heavy firms will also contain stocks of import heavy firms (Hull, 2009).

3.7.2 Non Hedging Strategies for Minimizing Foreign Exchange Risk

An obvious way for a firm to reduce its foreign exchange rate risk on international transactions without the need for hedging strategies is to bill in the firms' local operating currency. This way it transfers the transaction exposure to other companies. For example, a South African company exporting to a Brazilian company can quote its sale price in Rands. In this way the Brazilian company will face the transaction exposure resulting from the uncertainty of the Rand. Another simple alternative is to price the export in the foreign currency applicable (The Brazilian Real) but to demand immediate payment, in which case the current spot rate will determine the Rand value of the export (Kelley, 2001). The problems with these methods are clear, the firm loses its competitive edge and the firm can lose a large amount of market share in the particular industry in which it operates.

A second method more applicable to larger firms that have frequent large amounts of foreign currency transactions, is a method called netting out. This method can minimise foreign exchange rate risk to a point where foreign currency exposure is small enough that the company may be better off accepting the exposure rather than incurring the costs involved in implementing an effective hedging strategy (Kelley, 2001). As an illustration consider a South African company with an amount receivable to the value of 10 million Brazilian Real

in 75 days. The currency risk on that amount receivable will be much less risky and more acceptable if the South African company must pay another Brazilian company 11 million Brazilian Real in 75 days. That is, the net exposure of the company becomes just one million Brazilian Real.

4 The Difficulties of Hedging with Futures

4.1 The Problem of Basis Risk

The basis in a futures contract refers to the difference between futures and spot prices. For a hedge to be perfect the basis must be riskless when the hedge is terminated. There are two main reasons why the basis may fail to be riskless (Sundaram & Das, 2010):

1: The asset being hedged may not be exactly the same as the underlying asset in the futures contract. Formally this is referred to as commodity basis risk. This is the underlying risk discussed under cross hedging below.

2: The second is a delivery date mismatch. Futures contracts have standardized maturity dates and these dates may not match with the hedgers' date of market commitment. The futures position used for hedging will have to be closed out before maturity; at this point the futures price will typically not be equal to the spot price, implying basis risk.

It is worth stressing that as time changes the spot price and futures price do not necessarily change by the same amount. It is for this reason a hedge may fail to be effective. In other words a hedge cannot be made entirely riskless in the presence of basis risk. Clearly a firm will desire a futures contract that is highly correlated with the spot position being hedged. Dale (1981) points out that not only does basis risk imply the need for firms to enter into futures contract that most closely follows the changes in the spot position, but also that it is ideal a firm finds a contract size that matches the firm's spot position of which it wishes to hedge. The next Issue of the minimum variance hedge ratio attempts to reduce the problem of basis risk.

4.2 The Minimum Variance Hedge Ratio

In the presence of basis risk, it is generally not optimal to hedge exposures one-for-one. The variance minimizing hedge ratio depends on the correlation between spot and futures price changes and it increases as this correlation increases. When correlation is perfect, the offsetting is perfect and a riskless hedge is obtained. Therefore as correlation increases we want to use a higher hedge ratio to take advantage of the greater offsetting of risk. Similarly

with zero correlation between spot and future price changes there is no offsetting of risks at all from hedging using futures. Any hedging with futures contract will only increase risk by creating uncertainty from a second source, namely the futures contract (Sundaram & Das, 2010).

Thus, by ascertaining the Minimum Variance Hedge ratio the hedger will find clarity to the three questions needed to effectively hedge (Sundaram & Das, 2010):

1. The best choice of futures contract to be used for hedging.
2. The size of the futures position to be entered into.
3. Does the hedger need to enter into a long or short position.

In practice when hedging is done using futures the daily marking to market will have an impact on the optimal hedge ratio. A small adjustment known as tailing the hedge can be made to allow for the impact of daily settlement. Daily marking to market does not substantially impact shorter term hedges. However over longer term hedges, failure to tail the hedge will lead to over-hedging and this will markedly increase the cash flow risk of the hedge (Sundaram & Das, 2010). Most previous studies, and including this study, do not take into account the effect that margin requirements can have on the effectiveness of a hedge. Shanker (1992) found that an increase in margin reduces hedging effectiveness of currency futures contracts.

Following Hill and Schneeweis (1982), Dale (1981) and Ederington (1979), who have shown that the optimal hedge ratio and hedge effectiveness is related to the covariance between spot and futures price changes, the variance of futures price changes and the variance of the spot price changes. But using Sundaram and Das (2010) as the backbone to arrive at the expression for the minimum variance hedge ratio, the minimum variance hedge ratio can be identified as follows:

Consider an investor with a commitment to buy Q units of an asset (given as S) at date T. To hedge this position the investor must:

- Take a long futures position of size H at the current futures price F.
- Close out the futures position at time T by taking a short (opposite) futures position of size H.
- Buys the required quantity (Q) of S on the spot market at time T.

Thus the net cash outflow for a long hedged position would be:

$$QS_T - H\,(F_T - F) \quad \textbf{(1.1)}$$

While, the net cash inflow for a short hedged position would be:

$$QS_T + H\,(F - F_T) \quad \textbf{(1.2)}$$

It can be seen that for both a long and short position the hedger would want to choose H (the size of the futures position) that will minimize the variance of the cash flow.

To find the minimum variance hedge ratio we can rewrite (1.1) in terms of price changes where $\Delta_S = S_T - S$ denotes the changes in spot prices and $\Delta_F = F_T - F$ denotes the changes in futures prices. If the quantity QS is added and subtracted we obtain:

$$\begin{aligned} QS - QS + QS_T - H\,(F_T - F) &= Q\,(St - S) - H\,(FT - F) + QS \\ &= Q\Delta_S - H\Delta_F + QS \end{aligned} \quad \textbf{(1.3)}$$

Let h = H/Q. Then (1.3) can be expressed in terms of the hedge ratio[7], h.

$$Q\,[\Delta_S - h\Delta_F] + QS \quad \textbf{(1.4)}$$

The hedger would of course want to pick the value of h that minimises the variance of the quantity, Q. Since the last term QS is known at the time the hedge is initiated it does not form part of the variance. Thus from (1.4) three sources contribute to the variance of a hedged cash flow:

- The variance of the spot price changes Δ_S which can be written as $\sigma^2(\Delta_S)$
- The variance of the futures price changes Δ_F which can be written as $\sigma^2(\Delta_F)$
- The covariance between these quantities which can be written as cov (Δ_S, Δ_F)

Rewriting (1.4) using the above notation the variance of a hedged cash flow is:

$$\begin{aligned} \text{Var}\,[Q\,(\Delta_S - h\Delta_F)] &= Q^2\,\text{Var}\,(\Delta_S - h\Delta_F) \\ &= Q^2\,[\sigma^2(\Delta_S) + h^2\,\sigma^2(\Delta_F) - 2h\,\text{cov}\,(\Delta_S, \Delta_F)] \end{aligned} \quad \textbf{(1.5)}$$

By taking the derivative of (1.5) with respect to h we can identify the point of minimum variance as:

$$h\sigma^2(\Delta_F) = \text{cov}\,(\Delta_S, \Delta_F) \quad \textbf{(1.6)}$$

Thus the variance minimising value of h can be written as (where h^* is the variance minimising hedge ratio):

$$h^* = \frac{\text{cov}\,(\Delta_S, \Delta_F)}{\sigma^2(\Delta_F)} \quad \textbf{(1.7)}$$

[7] The hedge ratio, h, measures the number of futures positions taken per unit of spot exposure. The optimal hedge ratio, h^*, is used to implement the optimal hedging strategy.

Alternatively h* can be expressed in terms of correlation between $\sigma(\Delta_S)$ and $\sigma(\Delta_F)$ as:

$$h^* = \rho \frac{\sigma(\Delta_S)}{\sigma(\Delta_F)} \quad \textbf{(1.8)}$$

As can be seen the optimal hedge ratio or the minimum variance hedge ratio is dependent on the correlation between spot and futures price changes.

4.3 Cross Hedging With Futures

When a hedger is unable to implement a direct hedge, a cross hedge can be an effective substitute. Bowman (2004) notes this is especially pertinent with emerging market currencies as these are less likely to be traded on any exchange. Emerging markets are more prone to currency crisis or volatile currency movements and any exposure to these currencies would make a hedging strategy seem wise.

Sundaram and Das (2010) define cross hedging as exposure on one asset that is hedged with a futures contract on another 'closely related' asset. For example suppose exposure to the USD/ZAR spot exchange rate is hedged using a USD/EUR futures contract. As such, a cross hedge typically eliminates a smaller proportion of risk than a direct hedge. But it allows the hedge to be created using an exchange traded instrument with the accompanying benefits of liquidity and lower costs then may be feasible with a similar over the counter solution, such as a forward contract (Bowman, 2004).

Cross hedging obviously implies commodity basis risk. This means that a hedge ratio of one is not always optimal. With cross hedging it is imperative that the hedger identify the minimum variance hedge ratio. Moreover Eaker and Grant (1987) stress that the effectiveness of cross hedging depends not only on the hedge ratio but also upon the identification of highly correlated assets and their stability over time. They further conclude that it is essential for the hedger to understand the economic relationship underlying the correlation and for this relationship to be continuously monitored for a cross hedge to accomplish the wanted results.

Taking into account their own advice on cross hedging Eaker and Grant (1987) empirically found that currency cross hedging does indeed offer risk reduction opportunities, but not as effective as direct currency hedges. Bowman (2004) also finds that cross hedging generally benefits emerging market currency exposure when compared to an unhedged currency exposure. Surprisingly, Bowman (2004) finds that cross hedging with a hedge ratio of one-to-one is often more effective than a cross hedge implemented using an optimal hedge ratio. It is

important however to bear in mind that Bowman's study was performed on emerging market currencies experiencing structural change. It would therefore be naïve to implement a simple one-to-one hedge rather than a hedge implemented using a precisely calculated hedge ratio in most circumstances.

4.4 Rolling Over the Hedge

As mentioned above the ideal hedging plan will match the maturity of the futures contract with the maturity of the exposure being hedged. Often the maturity date of the contract being hedged is later than the delivery date of all the futures contracts that can be used. Moreover even if later maturities exist that closely match the maturity date of the exposure being hedged these contracts are often illiquid. This is expected to be especially prominent in emerging markets or emerging market currencies with smaller, less effective and less liquid derivative markets or contracts. This discussion is therefore necessary to make the reader aware of the various complications that may arise in hedging emerging market currency exposure even though these complications are not empirically tested in this thesis.

Often a strategy used to get around the problem of the lack of sufficiently lengthy futures contract maturity dates is the Stack and Roll strategy. The stack part of this strategy refers to the firm taking long/short positions in nearby futures contracts, to cover its full exposure. At the end of each period the firm closes out its entire position and opens new long/short positions to cover its remaining exposure, this is the roll part (Sundaram & Das, 2010). However there are serious cash flow problems that prevail with such a strategy. A clear problem is the possibility of huge margin calls on the futures position while the cash flow from the underlying contract may only materialise at a date far into the future. This of course can result in the firm becoming severely cash strained. For a more in depth analysis of such a strategy and the severity of a failed Stack and Roll strategy, the reader is referred to the case of Metallgesellschaft AG (MGRM) (Sundaram & Das, 2010).

Gardner (1989) examines the ability of such roll over strategies to provide an effective hedge. He points out that the two major problems of such strategies are high transactions costs and significant basis risk. Gardner questions the use of rollovers as a routine hedging strategy. It must be noted that Gardner (1989) does his examination on agricultural commodities, and the case of MGRM involved oil contracts. As such the unattractiveness of rollover strategies may

be exaggerated relative to using such strategies in the much more liquid foreign exchange market.

5 Testing Hedge Effectiveness using Regression Analysis

Hill and Schneeweis (1982) examined futures contracts on five currencies. They found that the British Pound, German Mark and Swiss Franc consistently exhibit high hedging effectiveness. Whereas they found the Japanese Yen and Canadian Dollar futures contracts to be an inferior vehicle for hedging although they do provide risk reduction compared to a completely unhedged position. Moreover it is shown that hedging effectiveness is weakest for the shortest durations (one week) and improves with longer hedging horizons. McCarthy (2003) found that while exposure to the Australian Dollar can be effectively hedged, it is preferable to leave exposure to the Singapore Dollar and Japanese Yen unhedged. Hill and Schneeweis (1982) and McCarthy (2003) both use methods similar to the ones being used in this thesis to test for hedge effectiveness (i.e., the effectiveness is tied to the correlation between the spot and futures price changes and the minimum variance hedge ratio).

Dale (1981) however finds very different results to Hill and Schneeweis (1982) in both the minimum variance hedge ratios and hedge effectiveness tests. Both authors analyse similar time periods and hedging intervals and Hill and Schneeweis (1982) find the Japanese Yen futures contract to be an inferior hedging instrument while Dale (1981) finds it to be highly effective.

Hill and Schneeweis (1981) point out the reason for this is that Dale (1981) uses spot and futures price levels whereas they used spot and futures price changes. Theoretical and statistical problems occur when testing hedge effectiveness using price levels. The objective of hedging is to reduce the firms exposure to exchange rate *changes,* therefore examining hedge effectiveness and hedge ratios using *levels* will lead to errors. Moreover using price levels in regression analysis means using variables that are nonstationary and this will lead to spurious regression results.

Kawaller and Koch (2000) also voice their concern on the choice between using price level and price changes in the regression analysis. Given that using price levels can result in inaccurate results it would seem price changes are more appropriate. However regression results using price changes may also be misleading. Kawaller and Koch (2000) consider such a case. Suppose the hedging instrument exhibits price changes about a constant mean and the

price of the hedged item exhibits parallel price changes but about a rising trend. In this circumstance price levels will be uncorrelated but price changes will be highly correlated. Using regression on price changes will thus indicate an effective hedge where indeed it is not an effective hedge. They conclude that performing a regression analysis on price changes is still the best method for testing hedge effectiveness however a situation such as the one above should be kept in mind. It is also important to note that this regression method is only suitable to measure the effectiveness of the optimal hedge ratio, where the regression coefficient is the hedge ratio. Kawaller and Koch (2000) expand on how using regression analysis is unsatisfactory in measuring any other possible hedge ratios.

It is noted that all the above currencies that have just been discussed belong to developed countries while this thesis relates to under-developed emerging currencies. The above examination gives all the more reason to examine currencies of emerging markets if hedging strategies involving well developed financial markets can be seen to be inefficient on occasion. However Dale (1981) hints that this should not necessarily be the case with currency futures markets. He reasons that the deliverable supplies of a currency is virtually unlimited and that most international trade takes place with a payment lag making currency futures contracts highly economically justifiable. Moreover speculators and arbitragers in currency markets are believed to be among the most sophisticated, which should help to maintain efficient markets.

These thoughts by Dale (1981) seem to be questioned by many authors who indeed find emerging market currency hedging with futures to be less effective than hard currency hedging with futures. A problem dealt with in this article is that of financial market under development, illiquidity and mispricing. Merrick (1988) mentions that mispricing in derivative contracts have an important implication for hedging cash market positions. Merrick (1988) notes, that the causes for possible mispricing can be attributed to transaction costs, immaturity of the arbitrage sector, market liquidity differences and general market inefficiency. A further implication of the illiquidity is that there is likely to be a lack of maturity dates available and thus many hedges will not be held to expiration and therefore, according to Merrick, the hedge will not be riskless. Finally Merrick (1988) concludes that there are methods available to adapt hedging techniques in order to account for the mispricing. He shows these to work well on stock index futures. However, these techniques will not be discussed in detail. Rather the objective of this thesis is to examine the effect that illiquidity and mispricing can have on the hedge effectiveness of emerging market currency

hedges using futures contracts. Choi (2009) confirms that difficulties are encountered when hedging for minor currencies. He defines minor currencies as those traded in illiquid markets. He states that in the case of minor currencies few seem to pass the threshold of hedge effectiveness well.

A common consideration taken into account by all the authors in the aforementioned articles is the relationship between hedge period length and hedge effectiveness. Benet (1992) gives the basic economic rationale offered to explain this relationship. The longer hedging length is supposed to allow for the resolution of some price uncertainty which would otherwise be reflected in higher basis risk. The decrease in this basis risk results in a closer tracking of the spot price by the futures price, achieving a more effective hedge. Another statistical explanation given by Benet (1992) is that longer hedges would allow for "noise" cancellation, allowing the true economic relationship between spot and futures prices to prevail in the longer run.

5.1 Other proposed testing methods

Besides the regression method used to test hedge effectiveness in this article, many other methods have been proposed. Perhaps the most basic testing method available is the Dollar Offset Method. The Dollar Offset Method is one of the methods proposed by the accounting standard FAS 133 to measure hedge effectiveness and has been embraced as the industry standard (Charnes et al., 2003). The Dollar Offset Method compares the changes in value of the hedged item to the changes in value of the derivative. In practice a hedge is considered effective when the cumulative change in the fair value (or cash flow) of the hedging derivative is expected to offset the cumulative change in the fair value (or cash flow) of the hedged item in the range of 80% to 125% or a ratio of 0.80 to 1.25. However Charnes et al. (2003) provide reasons with why this method is not usually used in empirical analysis of hedge effectiveness. The fundamental problem is that small changes in the underlying will have a larger than justified impact on the Dollar Offset Ratio. Moreover it does not explicitly account for the strength of the hedging relation (correlation) nor does it account for the minimum variance hedge ratio used. This method has many proposed modifications such as the Lipp Modulated dollar offset model and the Schleifer–Lipp modulated dollar offset model (Hailer & Rump, 2005).

Another method recognised by FAS 133 is the Variability Reduction Method (Finnerty & Grant, 2003). To measure hedge effectiveness using this method, an entity compares the

statistical variance of the combined position (of the underlying hedged exposure and the hedging instrument) to the statistical variance of the underlying unhedged exposure on its own. If the hedge is highly effective the variance of the combined position is small relative to the variance of the unhedged exposure.

Yet another proposed method that expands on the normal regression model is Deloitte's R^3 model. This model uses a Monte Carlo simulation to simulate historical prices and then uses regression to determine the relationship (Deloitte, 2011). Other studies attempt to encourage the use of added models rather than the simple regression model to test hedge effectiveness. Lien and Tse (2002) question the use of variance at all. They believe as far as hedging is concerned the downside risk should be the only relevant measure of risk. They further point to the difficulty of a simple regression analysis to deal with the presence of stochastic trends and unit roots in the data. Herbst, Kare, and Caples (1989) propose using Box-Jenkins ARIMA technique to evaluate the minimum variance hedge ratio and the hedge effectiveness. They found that a simple regression slightly overestimated the hedge ratios and effectiveness. Lien and Tse (2002) also question the use of a simple regression analysis and suggest the use of models that take into account the possible existence of a unit root such as the co-integration approach or the GARCH framework.

Charnes et al. (2003) believe that none the above measures of effectiveness provide the optimal picture of hedge effectiveness. They propose braking down the effectiveness of a hedge into three distinct measures. The potential effectiveness of a hedging instrument, the first step, should be measured separately to the attained effectiveness of a selected hedge ratio, the second step. The third step would be to combine the above two effectiveness measures to obtain the overall hedge effectiveness.

6 Hedging and Competitors

It is important for corporations that are hedging their exposures to currency risk, to examine the extent to which other competitors hedge their currency exposure to emerging market countries in which they operate. Hedging with futures means the firm sacrifices any upside gains that may have arisen without the hedge in place. Therefore if the exchange rate moves favourably for the particular industry that the corporation in question operates in, the competitors will outperform due to the competitors flexibility to change pricing policies. Obviously an adverse price movement will mean that the firm that is hedged would have the competitive advantage (Kawaller, 2012). This implies that even if the hedge entered into

were to be perfectly effective in the sense that the changes in fair value or cash flow of the hedged item and the hedging derivative offset each other to a significant extent. If prices moved favourably for the industry as a whole, the fact that the firm entered into the hedge may still impact negatively on the firms' bottom line due to the stiffness of its pricing policy created by the hedge.

Hull (2009) discusses how hedging may not make sense for a company if hedging is not the norm in the particular industry. This usually arises in industries in which the retail and cost prices of goods produced by the industry fluctuate simultaneously with exchange rate movements. Thus a company can expect its profit margins to be roughly constant. However a company which decides to hedge against the norm will actually have fluctuating profit margins due to the fixed exchange rate costs provided by the futures contract.

7 Research Methodology

As mentioned previously, hedge accounting is a privilege, not a right. The accounting standard FAS 133 currently regulates which firms may apply hedge accounting. The standard sets out various measures to test for hedge effectiveness. It authorises statistical methods, including a simple regression analysis, to test for effectiveness in order for a firm to obtain the privilege of applying hedge accounting in its financial statements.

A regression analysis is an important tool used to understand or quantify the relationship between two or more variables. In our case, since only two variables are being tested (the underlying price and the futures contract price), a simple regression is sufficient. This is essentially a numerical measure of the degree the patterns in the movement of X and Y correspond. Regression can be thought of as a best fitting line drawn through an XY plot of the two variables. Thus we can express this linear relationship between X and Y mathematically as:

$$Y = \propto + \beta x + \varepsilon$$

The linear regression model will only be an approximation of the true relationship. How well this approximation fits the true values can be measured using the R^2 statistic. Intuitively the R^2 measures the proportion of the total variance of Y that can be explained by X, i.e., the extent to which high (low) values of Y are associated to high (low) values of X. Therefore this goodness of fit statistic, R^2, provides us with a measure to evaluate the effectiveness of the optimal hedge over the sample period investigated. Clearly a higher R^2 will indicate

greater confidence that the optimal hedge will be effective. It is important to note that using R^2 to measure hedge effectiveness is only appropriate to measure an optimal hedge, i.e., a hedge that will be implemented using the minimum variance hedge ratio, which is shown below to be β from the regression equation (Kawaller & Koch, 2000). Recall that an R^2 of 80% or more is considered an effective hedge. In other words a hedge implemented with a hedge ratio equal to the regression slope coefficient,β, would have been effective if the R^2 is shown to be greater than 80%.

IAS 39 does not specify exactly how regression analysis should be performed however this thesis will follow Kawaller & Koch (2000) as well as Sundaram and Das (2010) and the majority of other academic studies on hedge effectiveness in which the regression equation is given as:

$$\delta_S = \propto + \beta\delta_F + \varepsilon \qquad \textbf{(1.9)}$$

Where δ_S denotes the daily (or weekly etc.) spot price changes[8] and δ_F denotes the daily (or weekly etc.) futures contract price changes.

The regression estimates are calculated to minimise the variance of the error term, ε and are of course unbiased estimates of the true values. Since $\propto$ is a constant, the variance of ε is:

$$Var(\varepsilon) = Var(\delta_S - \propto - \beta\delta_F) = Var(\delta_S - \beta\delta_F)$$

Thus the estimate of β minimises the variance of $(\delta_S - \beta\delta_F)$. As can be seen in equation 1.4 the optimal hedge ratio, h^*, was chosen to minimise the variance of $(\Delta_S - h\Delta_F)$. Since the difference between the spot price change over the hedging horizon and h times the futures price change over the hedging horizon $(\Delta_S - h\Delta_F)$ is made up of the difference between daily spot price changes and β times the daily futures price changes$(\delta_S - \beta\delta_F)$, the two scenarios must have the same solution. Therefore calculating β is identical to calculating h^* using the formula $h^* = \rho \frac{\sigma(\Delta_S)}{\sigma(\Delta_F)}$ (Sundaram & Das, 2010).

A more informative way of understanding the R^2 statistic and why it provides us with a good measure to evaluate the effectiveness of the optimal hedge, is by expanding on the calculations of Sundaram and Das (2010) which were used earlier to identify the minimum variance hedge ratio. Hedging tries to minimise the variance of cash-flows and it is therefore

[8] As discussed earlier using price changes and not levels in the regression analysis is the correct approach.

of interest to know what the variance of cash flows is from a hedged position which used the variance minimising hedge ratio, h^*. To identify the minimised cash-flow variance we substitute the value of h^* into equation 1.5. Keeping in mind that $cov\ (\Delta_S, \Delta_F) = \rho\ \sigma(\Delta_S)\sigma(\Delta_F)$, we obtain:

$$Q^2[\sigma^2(\Delta_S) + \rho^2 \frac{\sigma^2(\Delta_S)}{\sigma^2(\Delta_F)}\sigma^2(\Delta_F) - 2\rho \frac{\sigma(\Delta_S)}{\sigma(\Delta_F)}\rho\sigma(\Delta_S)\sigma(\Delta_F)] \quad \textbf{(1.10)}$$

Once simplified we get:

$$Q^2\sigma^2(\Delta_S)(1-\rho^2) \quad \textbf{(1.11)}$$

Equation 1.11 suggests that the minimized variance will be zero when ρ = 1, i.e. when the spot and futures price changes are perfectly correlated. Perfect correlation occurs only when there is no basis risk. In other words this equation implies that if basis risk is present, which is normally the case, there is always some remaining uncertainty even after hedging using h^*.

We are now in a position to ask the question of, by how much optimal hedging reduces uncertainty over the alternative of not hedging? In the case of no hedging the hedge ratio, *h,* equals zero. Substituting this into equation 1.5 the variance of the unhedged cash flow becomes:

$$Q^2\sigma^2(\Delta_S) \quad \textbf{(1.12)}$$

Finally, comparing equation 1.12 to equation 1.11, optimal hedging can be seen to reduce cash-flow variance by an amount of ρ^2. For example if $\rho = 90\%$ then optimal hedging removes 81% of the cash-flow variance relative to an unhedged position ($0.90^2 = 0.81\%$). Of course ρ^2 in a simple regression is the same as the R^2 statistic. The importance of correlation between spot and futures price changes in order for a hedge to be effective should be clear by now.

It is also interesting too show how hedging one-for-one may even be worse than not hedging at all. Still following Sundaram and Das (2010) and going back to equation 1.5 once again. Hedging one-for-one means using a hedge ratio of one, *h* = 1. Plugging this into equation 1.5 the variance of cash-flows becomes:

$$Q^2[\sigma^2(\Delta_S) + \sigma^2(\Delta_F) - 2cov(\Delta_S), (\Delta_F)] \quad \textbf{(1.13)}$$

Equation 1.13 can be rewritten as:

$$Q^2[\sigma^2(\Delta_S)(1-\rho^2)] + Q^2[\sigma(\Delta_F) - \rho\sigma(\Delta_S)]^2 \quad \textbf{(1.14)}$$

Comparing equation 1.14 to equation 1.11, it can be seen that using a hedge ratio of one actually increases the variance by $[\sigma(\Delta_F) - \rho\sigma(\Delta_S)]^2$. The lower the correlation, ρ, the greater the increase in variance is, relative to hedging using a hedge ratio of h*. Similarly when comparing equation 1.14 to 1.12 it can be seen that hedging one-for-one can result in a higher variance compared to a completely unhedged position.

Hill and Schneeweis (1981) show that the duration of the hedge contract has an impact on the effectiveness of the hedge. Short term hedges such as one week are often not very effective while longer term hedges of nine to twelve months become very effective. For this reason testing will take place for three different duration's, short term hedges of one week, medium term hedges of four weeks and long term hedges of 12 months or over the entire life of the futures contract if the contracts life was less than 12 months. Moreover, following the methods used by Hill and Schneeweis (1982) who note that since time to delivery may affect the minimum hedge ratio and hedging effectiveness, the effectiveness of the weekly and four weekly hedge durations above are examined with contracts separated into four, three month periods, representing time to delivery, ranging from zero to three months from expiration date of the futures contract (being the closest to delivery) and nine to twelve months from expiration date of the futures contract (being furthest from delivery). For the weekly hedge tests, the regression is done on the first trading week or five days of each of the four three-month periods. If the regression was insignificant using only five days, the regression was re-run using seven days. If this was still insignificant a five day regression was done on the second week of the particular period and so on. The same method was used for the four week hedge testing.

The Significance F-test was used to test for significance at a 90% confidence level. A significant F-value of below 0.10 would indicate that R^2 does not equal zero. In other words we can reject the null hypothesis that R^2 equals zero and accept the alternative hypothesis that R^2 does not equal zero[9].

The daily data used for both the underlying spot prices and the futures contract prices was sourced from Bloomberg. The futures contracts chosen are contracts that have expired in

[9] The data was tested for auto-correlation using the Durbin Watson test. No auto-correlations were found.

2011. However tests on the Brazilian Real are done using a contract that matured in 2010 since no data on 2011 contracts were available. Active contracts were not chosen so that testing can be conducted using price data up until expiration since it is not unusual for futures prices to be quite erratic during the delivery month (Hull, 2009). All the futures contracts besides that of India were written by the Chicago Mercantile Exchange whereas the contract used for India was issued by The United Stock Exchange of India.

8 Results

Table 1 to 6 below show the results of the multiple regressions run on each of the six emerging market currencies. Results indicate that hedging emerging market currency risk using futures is often ineffective and seems to be largely country dependant. What is particularly striking is that only South Africa and Turkey consistently exhibit high hedge effectiveness or R^2 of above 80%. However, a major outlier in the Turkey data set was removed for the 12 month test. Not removing it would have resulted in one R^2 of 32%. The reason for such an extreme outlier is not known. While Russia failed the hedge effectiveness test only once, it is noted that it failed the weekly test with only a few days remaining on the contract, a period of time in which futures contracts are notoriously volatile and as such can contribute to an ineffective hedge. The results for Mexico show reasonable hedge effectiveness, although failing the regressions test multiple times, the R^2 dropped significantly below 80% only once.

The results from Brazil and India show some extreme results with the R^2 being as low as 12% for India. However logical explanations can be offered to explain the extreme results for both these countries. Tests on Brazil were done using 2010 data. At this time emerging markets were still particularly sensitive to capital flows given that investors were still extra cautious of risker emerging market countries after the global financial crisis. These sensitive conditions in the market would have led to extremely volatile futures contracts and thereby rendering futures contracts as an ineffective hedging mechanism. The futures contract obtained for India was written by the relatively new United Stock Exchange of India unlike the others which were written by the much larger, more liquid and globally reputed Chicago Mercantile Exchange.

When looking at the *broad* results of the tests, there seems to be little indication that weekly tests should be less effective than longer hedge period tests. There also seems to be no indication that the weeks closest to expiration should be more volatile and thus lead to lower

hedge effectiveness. This is contrary to the theory suggested by Hill and Schneeweis (1982) and others such as McCarthy (2003) who follows this view.

The results confirm the views of Merrick (1988) who in his article concludes that hedging emerging market currencies can often be ineffective due to mispricing and the lack of liquidity. Furthermore, comparing these results to the results obtained by Hill and Schneeweis (1982), an article which examined only developed markets and found consistent hedge effectiveness in the majority of them. It is clear that emerging market currency hedging fails the effectiveness test far more regularly. Moreover, the tests of Hill and Schneeweis (1982) were conducted at a time when financial markets were tiny relative to the size and liquidity of these markets today. Given that developed market currencies were passing the effectiveness test in the year 1982, further compounds the failure of current futures contracts to hedge emerging market currencies. Finally, McCarthy (2003) finds that it is preferable not to hedge exposure to the Singaporean Dollar, meaning hedging the emerging market currency of Singapore would be ineffective. Consequently, the results obtained in this article seem to be consistent with previous research regarding hedge effectiveness using futures contracts.

Table 1: Brazil test results

	Time remaining to maturity of Futures Contract							
Duration of Hedge	**9 to 12 Months**		**6 to 9 Months**		**3 to 6 Months**		**0 to 3 Months**	
	Effectiveness	**Hedge Ratio**	**Effectiveness**	**Hedge Ratio**	**Effectiveness**	**Hedge Ratio**	**Effectiveness**	**Hedge Ratio**
One Week	0.96	-0.82	0.44	-1.42	0.47	-1.39	0.99	-1.03
Four Weeks	0.73	-0.73	0.67	-1.03	0.62	-1.11	0.98	-0.97
12 Months	0.69	-0.90						

Table 2: India test results

	Time remaining to maturity of Futures Contract							
Duration of Hedge	**9 to 12 Months**		**6 to 9 Months**		**3 to 6 Months**		**0 to 3 Months**	
	Effectiveness	**Hedge Ratio**	**Effectiveness**	**Hedge Ratio**	**Effectiveness**	**Hedge Ratio**	**Effectiveness**	**Hedge Ratio**
One Week	0.90	2.54	0.88	0.73	0.71	0.83	0.95	0.95
Four Weeks	0.54	0.87	0.12	0.40	0.13	0.27	0.95	1.03
12 Months	0.55	0.70						

Table 3: Mexico test results

	Time remaining to maturity of Futures Contract							
Duration of Hedge	**9 to 12 Months**		**6 to 9 Months**		**3 to 6 Months**		**0 to 3 Months**	
	Effectiveness	**Hedge Ratio**	**Effectiveness**	**Hedge Ratio**	**Effectiveness**	**Hedge Ratio**	**Effectiveness**	**Hedge Ratio**
One Week	0.91	-0.78	0.93	-0.84	0.67	-0.53	0.96	-1.09
Four Weeks	0.84	-0.77	0.78	-0.69	0.73	-0.73	0.85	-0.92
12 Months	0.79	-0.81						

Table 4: Russia test results

	Time remaining to maturity of Futures Contract							
Duration of Hedge	**9 to 12 Months**		**6 to 9 Months**		**3 to 6 Months**		**0 to 3 Months**	
	Effectiveness	**Hedge Ratio**	**Effectiveness**	**Hedge Ratio**	**Effectiveness**	**Hedge Ratio**	**Effectiveness**	**Hedge Ratio**
One Week	0.86	-0.50	0.84	-0.98	0.87	-0.96	0.50	-1.26
Four Weeks	0.96	-0.86	0.81	-0.98	0.89	-1.07	0.84	-1.03
12 Months	0.82	-0.89						

Table 5: South Africa test results

	Time remaining to maturity of Futures Contract							
Duration of Hedge	**9 to 12 Months**		**6 to 9 Months**		**3 to 6 Months**		**0 to 3 Months**	
	Effectiveness	**Hedge Ratio**	**Effectiveness**	**Hedge Ratio**	**Effectiveness**	**Hedge Ratio**	**Effectiveness**	**Hedge Ratio**
One Week	0.91	-0.85	0.95	-0.90	0.99	-1.03	0.97	-1.14
Four Weeks	0.92	-0.90	0.85	-0.75	0.97	-1.02	0.94	-1.01
12 Months	0.85	-0.91						

Table 6: Turkey test results

	Time remaining to maturity of Futures Contract							
Duration of Hedge	**9 to 12 Months**		**6 to 9 Months**		**3 to 6 Months**		**0 to 3 Months**	
	Effectiveness	**Hedge Ratio**	**Effectiveness**	**Hedge Ratio**	**Effectiveness**	**Hedge Ratio**	**Effectiveness**	**Hedge Ratio**
One Week	0.97	1.12	0.97	0.80	0.97	0.71	0.86	0.57
Four Weeks	0.94	0.95	0.91	0.92	0.93	0.94	0.86	0.74
12 Months	0.89	0.92						

9 Conclusion

This study examined the effectiveness of hedging foreign exchange rate risk using futures contracts. Although it followed the methodology of previous research on this topic, it differed importantly in that it focused purely on Emerging Market currencies. It has been shown that emerging market currencies are less liquid, derivative contracts on minor currencies are often mispriced and are less likely to pass the threshold for hedge effectiveness. Illiquidity and mispricing in the futures market can mean that the futures contracts price will not be sufficiently correlated to the underlying currency and thus lead to an ineffective hedge. The importance for corporations to know the extent that their competitor's hedge foreign exchange rate risk, was also emphasised as a vital point for corporations to execute an ultimately effective hedging program.

It is hoped that this thesis contributes to the understanding of the importance for corporations to have the necessary expertise in selecting the appropriate hedging programs. The ability of appropriate hedging programs to lower the costs of financial distress, negative profit realisations and improve the firms' access to capital was highlighted. Moreover new accounting standards in the form of IFRS 9 are expected to replace FAS 133. The new IFRS 9 states that establishing hedge effectiveness in order to qualify for hedge accounting no longer needs to be proved by quantitative methods only but can now also be proved by qualitative methods (Deloitte & Touche, 2011). This study's outcome therefore helps as a qualitative and quantitative proof as to what may be considered an effective hedge in an emerging market context.

Testing for effectiveness was done using regression analysis. Results indicate consistent hedge effectiveness in only South Africa and Turkey, with reasonable hedge effectiveness exhibited by Mexico and Russia. Sensible explanations were given for the extreme hedge ineffectiveness that can be seen in the Brazilian and Indian tests. Tests on Brazil were done using 2010 data, at this time emerging markets were still particularly sensitive to capital flows given that investors were still extra cautious of risker emerging market countries after the global financial crisis. It would be interesting to conduct further tests on each currency around the time of the financial crisis of 2008 and examine the effect that the uncertainty had on hedge effectiveness relative to the results obtained in this article. Likewise, the futures contract obtained for India was written by the relatively new United Stock Exchange of India unlike the others which were written by the much larger, more effective and globally

reputable Chicago Mercantile Exchange. Further studies that examine the hedge effectiveness of futures contracts written by each countries home exchange, and compare the results to the hedge effectiveness of those written by the Chicago Mercantile Exchange may give an even more clear indication on the mispricing and illiquidity in emerging market currencies. In summary, the results indicate that hedging emerging market currency risk using futures is often ineffective and seems to be largely country dependant. Illiquidity and market mispricing of futures contracts, combined with the deficiency of choice for maturity dates available for minor currency futures contracts makes for hedging emerging market currency risk a seemingly tricky business. However as can be seen from the mention of the two topics for possible further study above, more research is needed to establish the true value in hedging individual emerging market currency risk using futures contracts.

10 Reference List

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